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*PHYSICAL HISTORY OF THE ROCKY MOUNTAIN REGION IN CANADA.**

IT will now be endeavored to briefly review the orographic changes and the conditions of deposition of which the geological column gives evidence—in other words, to touch in outline the main facts of the physical history of the Rocky Mountain region of Canada.

Regarding the Archean, it need only be said that here, as in most parts of the world, we find, beneath any rocks that can be assigned to the Cambrian in the most extended sense of that term, and apparently separated from these rocks, by a great break and unconformity, a crystalline series or 'fundamental complex' composed of plutonic rocks with highly metamorphosed and vanishing sedimentary rocks in seemingly inextricable association. The similarity of this basal series in different parts of the world is so great as apparently to imply world-wide and approximately contemporaneous conditions, of a kind perhaps differing from any that can have occurred at later periods. The region here described is not, however, an ideal one for the study of these Archean rocks, because of the extreme metamorphism by which much newer formations

* Concluding section of the address of the President of the Geological Society of America, the late Dr. George M. Dawson, read before the Society on December 29, 1900.

have often been affected in it; nor has any series yet been defined that appears here to bridge the gap between the Archean and the strata that may with propriety be attached to the Cambrian.

In the earlier series of deposits assigned to the Cambrian, we discover evidence of a more or less continuous land area occupying the position of the Gold ranges and their northern representatives, and aligned in a generally northwesterly direction. The Archean rocks were here undergoing denudation, and it is along this axis that they are still chiefly exposed, for although they may at more than one time have been entirely buried beneath accumulating strata, they have been brought to the surface again by succeeding uplifts and renewed denudation. We find here, in effect, an Archean axis or geanticline that constitutes, I believe, the key to the structure of this entire region of the Cordillera. To the east of it lies the Laramide geosyncline (with the conception of which Dana has familiarized us) on the west another and wider geosyncline, to which more detailed allusion will be made later.

Conglomerates in the Bow River series indicate sea margins on the east side of this old land, but these are not a marked feature in the Nisconlith, or corresponding series on its western side. Fossils have so far been discovered only in the upper part of the Bow River series, but the prevalence of carbonaceous and calcareous material (particularly in the Nisconlith) appears to indicate the abundant presence of organisms of some kind at this time.

Although no evidence has been found of any great physical break, the conditions indicated by the upper half of the Cambrian are very different from those of the lower. Volcanic materials, due to local eruptions, were accumulated in great mass in the region bordering on the Archean axis to the west, while on the east materials of this kind appear to be mingled with the preponderant shore deposits of that side of the Archean land, and to enter sparingly into the composition of the generally calcareous sediments lying still farther eastward. Where these sediments now appear in the eastern part of the Laramide range they are chiefly limestone, indicating marine deposition at a considerable distance from any land.

The history of the Ordovician, Silurian and Devonian times is very imperfectly known. Marine conditions still prevailed to the eastward of the Archean axis and were probably continuous there, but our knowledge of the region to the west, while as yet almost entirely negative in its character, is not sufficiently complete to enable us to assume the existence of any extensive land area in that quarter. In the Devonian the sea is known to have covered a great area in the interior of the continent, extending far to the north in the Mackenzie basin, and it appears probable that considerable portions of the western part of the Cordilleran region were also submerged, particularly to the north.

About the beginning of the Carboniferous period and thence onward the evidence becomes much more satisfactory and complete. In the earlier part of the Carboniferous, marine sediments, chiefly limestones, were laid down everywhere to the east of the Archean axis, while to the west of that axis (which was probably in large part itself submerged) ordinary clastic deposits, mingled with contemporaneous volcanic materials, were formed, tranquil epochs being marked by the intercalation of occasional limestone beds. It is not clearly apparent from what land the clastic materials were derived, but the area of vulcanism at this time was very great, covering the entire western part of British Columbia to the edge of the continental plateau and, as now known, extending northwest-

ward into Alaska and southward to California.

In the later time of the Carboniferous, however, the volcanic forces declined in their activity, and a great thickness of calcareous marine deposits occurred with little interruption of any kind. The area of land to the eastward was probably increased, for there is some evidence to show a first gentle uprising in the Laramide region at this time (or at least a cessation of subsidence), and no late Carboniferous strata have so far been found there.

No separate record for the Permian has yet been found in this part of the continent, but it must be remembered that, in view of the scanty character of the paleontological evidence, strict taxonomic boundaries can seldom be drawn. At about this time, however, very important changes occurred, for in the Triassic a great part of what is now the inland plain of the continent is found to have become the bed of a sea shut off from the main ocean, in which red rocks with salt and gypsum in some places were laid down. The northern part of this sea appears to have extended into the Canadian region for a short distance, covering the southern portion of the Laramide area. Farther north must have been the land boundary of this sea, and beyond this an extension of the Pacific ocean which swept entirely across the Cordillera. In the southern part of British Columbia, however, this ocean found its shore against the Gold ranges of the Archean axis, where the preceding Carboniferous beds had already been upturned and subjected to denudation. The Laramide region was not affected by volcanic action at this time, but vulcanism on a great scale was resumed in the entire western part of the Cordillera that had previously been similarly affected in the Carboniferous, and the ordinary marine sediments there form intercalations only in a great mass of volcanic products, probably in large part the result of submarine eruptions.

Such definite indications as exist of the Jurassic must, as already noted, be considered as physically attached to the Triassic of the interior plateau of British Columbia. It is probable that the greater part of the Jurassic period was characterized by renewed orogenic movements and by denudation, for when we are next able to form a connected idea of the physical conditions of the region these are found to have been profoundly modified.

It is to about this time that the elevation of the Sierra Nevada and some other mountain systems in the western states is attributed. In the region here particularly described, the Triassic and older rocks of the Vancouver range, or that forming Vancouver and the Queen Charlotte islands, were upturned, while a similar movement affected the zone now occupied by the British Columbia Coast ranges. These may not have been elevated into a continuous mountain system and barrier to the sea, but in any case the ranges then formed were, before the beginning of the Cretaceous period, largely broken down by denudation, so that the underlying granitic rocks supplied abundant arkose material to some of the lowest Cretaceous beds.

It is also probable that subsidence marked the close of the Jurassic, for in southern British Columbia the Pacific of the Earlier Cretaceous extended more or less continuously across the line of the Coast ranges, finding its shore not far to the east of this line. Farther north, although not without insular interruptions, it spread over the entire width of the Cordilleran belt, repeating the conditions found in the Triassic, but with the difference that it extended far to the south along the axis of the Laramide geosyncline, in which rapid subsidence had been renewed. In this early Cretaceous sea and along its margins and lagoons the

massive fossiliferous rocks of the Queen Charlotte islands and Kootanie formations were accumulated and coal beds were produced. Volcanic activity was renewed in some places, particularly near the present seaward margin of British Columbia. Sedimentation evidently proceeded more rapidly than subsidence in many localities and coal-producing forests, largely composed of cycadaceous plants, took possession of the newly formed lands from time to time.

The era of later Cretaceous appears, however, eventually to have been introduced by a marked general subsidence, which, as already noted, carried the Dakota sea entirely across the inland plain of the continent. The distribution and character of the ensuing Cretaceous formations show that the whole southern part of what is now the mainland of British Columbia soon after became and remained a land area, while the sea was more gradually excluded from the northern part of the Cordillera and continued to occupy the area of the Great plains and the present position of the Laramide range. Along the margin of the continental plateau, however, a renewed subsidence was in the main progressing southward and resulted ultimately in carrying the later Cretaceous sediments into the region of Puget sound.

The closing event of this cycle was the deposition of the Laramie beds on the east and in some places to the north, with probably the Puget group and its representatives on the coast, and this was followed by the most important and widespread orogenic movement of which we find evidence in the entire Rocky Mountain region. At this time the great Laramide range, or Rocky Mountain range proper, was produced, rising on the eastern side of the Archean axis along a zone that had previously been characterized from the dawn of the Paleozoic by almost uninterrupted subsidence and sedimentation. That the pressure causing this upthrust of the Laramide range was from the westward is clearly shown by the great overthrust faults in this range. The stability of the old Archean axis, which it may be supposed had previously sustained the tangential thrust from the Pacific basin must at this time have been at last overcome. As a part of the result of this, the chief belt of faulted strata in the Laramide range, originally about 50 miles wide, became reduced in width by one-half. How rapidly this great revolution may have occurred we do not know, but it probably did not occupy a long time from a geological point of view, and the Laramide range, as first produced, may very possibly have attained a height approaching 20,000 feet.* The thickness of stratified rocks in the geosyncline was at the time probably more than 40,000 feet.

It is difficult to determine to what extent the Archean axis with the Gold ranges and other preexisting mountains was affected at this period of orogenic movement, because of the absence of the newer formations there, but it seems probable that no very important change took place. Farther west, however, the great zone of Coast ranges was elevated, and the corrugated and vertical Cretaceous beds, met with even on their inland side, show that large parts of the Interior plateau of British Columbia and of the country in line with it to the northward were flexed and broken. Similar conditions are found to have affected Cretaceous rocks of Vancouver and the Queen Charlotte islands, of which the

* This refers particularly to the better known region near the Bow pass. See Annual Report, Geol. Surv. Can. (N. S.) Vol. II., p. 31 D, and *Am. Jour. Sci.*, Vol. XLIX., p. 463. The base of the mountains may at this time have been nearly at sea level, or 4,000 feet lower than at present, while the actual height at any time attained would depend upon the rapidity of uplift relative to denudation. The total height of folded strata is estimated at from 32,000 to 35,000 feet.

mountain axis, previously in existence, was evidently greatly increased in elevation.

The Laramide geosyncline has already been particularly referred to and allusion has been made to the now well recognized fact that by such zones of continued subsidence and deposition the lines of most mountain systems have been determined. To the Laramide geosyncline here, the mountains of the Archean axis—the Gold ranges—stood in much the same relation as the Archean western border of the Wasatch to the Laramide geosyncline in Utah (as described by Dana), but on a larger scale.

On the other or western side of this axis, as already noted, I am now led to regard the zone of country extending to the Vancouver range as a second and wider geosyncline with a breadth of about 200 miles, in which a thickness of deposits, perhaps greater than that of the Laramide, but in the main composed of volcanic ejectamenta, had by this time been accumulated. The volume of the Carboniferous and Triassic rocks alone must have exceeded 20,000 feet. It is probable that to this may be added a great thickness of older rocks,* for the circumstance that volcanic action was so persistent here and the amount of extravasation resulting from it was so enormous, implies a recognition of the fact that, along this zone (not far from the edge of the continental plateau) the isogeotherms, with what we may call the plane of granitic fusion, had crept up to a position abnormally near the surface. It is to this probably that we may attribute the apparent absence of Archean rocks in the Coast ranges, or at least the impossibility of defining any rocks of that period there, for these, together, no doubt, with great volumes of later deposits, may be assumed to have become merged in the rising granitic magma, on which strata of Triassic age are now often found lying directly, arrested in the very process of absorption.*

When the Laramide revolution occurred, by reason of the increasing tangential pressure from the Pacific basin and the growing failure of resistance of the two great geosynclines of this part of the Cordillera, the Laramide range was produced by the folding and fracture of a very thick mass of beds, of which the crystalline base has not yet been revealed by denudation, while in the western trough an eversion of the axis of settlement seems to have occurred, resulting in the appearance of a granitic bathylite of nearly a thousand miles in length, from which the comparatively thin covering of unabsorbed beds was soon afterward almost completely stripped away by ensuing processes of waste.

This last great epoch of mountain making doubtless left the surface of the Cordilleran belt generally with a very strong and newly made relief, which before the middle of the Tertiary period is found to have become greatly modified by denudation. Chiefly because no deposits referable to the Eocene or earliest Tertiary have been found in this part of the Cordillera, it is assumed with probability that this was a time of denudation. It is further indicated that it was a time of stability in elevation by the fact that the prolonged wearing down resulted, in the interior zone of the Cordillera, in the production of a great peneplain, the base-level of which shows that the area affected stood for a very long time 2,000 or 3,000 feet lower in relation to the sea than it now does. If, however, the Puget beds of the coast are correctly referred to the Eocene, it follows that the coast region was at the same period

*Several thousand feet of Cretaceous rocks must also be added to this thickness near the line of the present Coast ranges, and the total thickness of deposits in the center of this geosyncline must probably have exceeded 40,000 feet.

*Annual Report, Geol. Surv. Can., Vol. II. (N. S.), 1886, p. 11 B et seq.

only slightly lower than at present, and that the movements in subsidence and elevation between this and the interior region must have been differential in character and very unequal in amount.

As already noted, the earliest Tertiary sediments of the Interior plateau of the Cordillera are referred to the Oligocene. Probably some further subsidence at that time interrupted the long preceding time of waste. This period of deposition was in turn closed by renewed disturbance of an orogenic kind, comparatively slight in amount and local, chiefly affecting certain lines in a northwest and southeast direction. Next came renewed denudation or 'planation,' and this continued until the enormous volcanic extravasations of the Miocene began.

It is not proposed in this place to recapitulate in detail the physical conditions of the Tertiary period, for it has already been necessary to refer to these in connection with the description of the beds themselves, which, because they have not been materially changed since their deposition, really tell their own tale.

It need only be said that, after the Oligocene lake deposits had been formed, disturbed and denuded, new series of lakes were from time to time produced at different stages during the Miocene, their beds now generally appearing as intercalations in volcanic deposits of great mass. Both the coast and the interior region appear to have been subject to these conditions, while the Laramide range stood high, with the inland plain of the continent sloping eastward from its base.

Following the close of, or at least a great reduction in, volcanic activity in the early Pliocene, the interior zone of the Cordillera again assumed a condition of stability for a considerable time, during which wide and 'mature' stream valleys were formed. The elevation of the interior plateau region of British Columbia must then have been about 2,000 feet less than it is at present.* Farther north, the yellow Pliocene gravels of Horsefly river and other places are attributed to this period, and the southern aspect of their contained fossil plants is such as to indicate that, in the given latitude, the height of that part of the interior can not have been much above the sea level.

In the later Pliocence a very marked reelevation of the Cordilleran region evidently occurred, leading to the renewed activity of river erosion, the cutting out of deep valleys and canyons, and the shaping of the surface to a form much like that held by it at the present day. This elevation in all probability affected the coast as well as the interior, and it would appear that the rivers for a time extended their courses to the edge of the continental plateau.

The excavation of the remarkable fiords of British Columbia and the southern part of Alaska must, I think, be chiefly attributed to the later portion of the Pliocene, although it is quite possible that the cutting out of the valleys may have been begun soon after the Laramide upheaval. The antiquity of these valleys is evidenced by the fact that several comparatively small rivers still flow completely across the Coast ranges in their deep troughs. The fiords are now essentially the submerged lower parts of these and other drainage valleys of the old land, not very materially affected by the later glacial action, important as this has undoubtedly been from other points of view. The valleys of the fiord-like lakes that occur along the flanks of the Archean axis of the interior may probably also be referred to river erosion in the later Pliocene, but if so this mountain region must have been affected by a relatively greater uplift at that time, followed later by a subsidence of its central part. It appears,

* *Trans. Royal Soc. Can.*, Vol. VIII., Sec. IV., p. 18.

however, that the excavation of valleys or gorges like these by rivers, when the slope and water supply are favorable, occurs with such rapidity relative to the wider effects of denudation, as to be almost negligible in any general view of the physical changes of an extensive region or in the accounting of geological time.

There is as yet some difficulty in connecting the later physical changes particularly referred to above with those which have recently come under observation far to the north in the Klondike region. It is probable, however, that the auriferous 'quartz drift' of that region, implying long subaërial decay and stability of level, may be attributed to the early Pliocene; while the river gravels found in the newer and deeper-cut valleys may be assigned to the later Pliocene time of greater elevation. During the Pliocene, and probably until its close, the mammoth, one or two species of bison, the moose and other large mammals roamed northward to the Arctic sea. Then came the Glacial period, with renewed great changes in levels and climate and its own peculiar records and history, which in many respects are more difficult of interpretation than those of more remote periods, because the whole time occupied by them has been relatively so brief. I have elsewhere endeavored to follow this history in detail, and do not propose on this occasion to deal with this latest chapter of the physical history of the Rocky Mountain region of Canada.

In conclusion, what appear to be the most striking points evidenced by the geological record of this northern part of the Cordillera may perhaps be specified as follows:

1. The great thickness of strata accumulated both to the east and west of an Archean axis. In the Laramide geosyncline the strata no doubt actually attained the volume stated. In the western and wider syncline it is not so certain that all the formations in their full thickness were ever actually superposed at any one place or time (for reasons already alluded to), but the volume was probably not less than in the Laramide region.

2. The great proportion of volcanic materials accumulated in the western geosyncline and the recurrence of vulcanism throughout the geological time-scale in this region, resulting in the production of massive volcanic formations in the Cambrian, Carboniferous, Triassic, Cretaceous and Miocene.

3. The recurrence of folding and disturbance parallel to the border of the Pacific basin and the concurrent great changes in elevation of the land relatively to the sea, both continued down to quite recent geological times, the latter even into the Pleistocene.

4. The tremendous energy of denudation, in part due to the events last referred to, but also dependent upon the position of the region on the eastern border of a great ocean, where, in northern latitudes, an excessive rainfall must have occurred at all periods on the seaward mountain ranges. No comparable denuding forces were probably ever operative on the east side of the continent in similar latitudes since the definition of the ocean basins of the Pacific and Atlantic.

G. M. DAWSON.
GEOLOGICAL SURVEY OF CANADA.

STEREOSCOPIC STUDY OF THE MOON.

IN looking at a terrestrial landscape we see that certain features are distant and others near. We also recognize the extension of objects in three dimensions, so that a tree, for example, is not a mere silhouette, but is perceived in its proper rotundity. The data for these automatic and instantaneous judgments as to distance and form are somewhat complex. The distance of

objects of familiar character is judged in part by their apparent size—the principle of lunar perspective. Distant objects, being seen through more air, have a different color from near objects—the principle of aërial perspective. For objects in the foreground we have two retinal pictures which are sensibly different, and from these the eyes estimate distance—the principle of optical parallax. The judgments arising from optical parallax are automatically combined into judgments of the rotundity or solidity of objects. If the sun shines, many objects show one side illuminated and the other side in shadow, and a shadow is also cast on the ground or on adjacent objects. From long association with judgments arising from optical parallax we have come to infer rotundity from the distribution of illumination and non-illumination—the principle of shadows. Finally, sunlight is scattered and reflected from particles in the air and from objects in the landscape so as to come with modified intensity from many directions, affording partial illumination to surfaces not directly exposed to the solar rays. This partial illumination we have learned to interpret in terms of rotundity—the principle of shades.

When one looks at the surface of the moon through a telescope of high power he sees a landscape from an unfamiliar direction and under unfamiliar conditions. As all the objects are strange, he is not aided by linear perspective. As there is no foreground, he is without the assistance of optical parallax. As the moon has no atmosphere his view is devoid of aërial perspective and of shades. It is true that the moon receives reflected light from the earth and there must also be reflection from lunar cliffs, but these reflected lights are so faint as not to help the seeing of surface details; so far as the eye can determine, the lunar shadow is absolutely black. The observer, being deprived of all other data, has to depend wholly on light and shadow, complete illumination and the entire lack of illumination, for his determination of the configuration of the surface. The sense of sight, having been educated by terrestrial landscapes, is unprepared for the peculiar conditions of the lunar landscape and gives false judgments. Close to the terminator, or sunrise line, where light and shadow divide the field, the eye overestimates the relief and sees the topography as grossly exaggerated as some of the published sketches of lunar mountains. At a distance of 40° or more from the terminator the landscape is practically without shadows, but is diversified by spots of color representing the distribution of the various substances composing the moon's face. These colors, being chiefly light and dark grays, are interpreted by the eye as shades and give an impression of relief no less false than that obtained at the terminator. Along an intermediate zone the general effect as to altitude is substantially true, but it can hardly be doubted that many details of form are misconceived.

Professor W. Prinz, of Brussels, has hit upon an ingenious method of avoiding these difficulties and realizing the actual relief. For many years the rotundity of the moon as a whole has been exhibited by means of the stereoscope. The possibility of this depends on libration, which permits us to view the moon from different directions ranging through an arc of about 16°. Two photographs taken in different months and at times properly chosen, and afterward viewed through a properly constructed stereoscope, give the same fulness of relief which we obtain in observing an object at a distance of 9 inches. Professor Prinz has applied the same method to the examination of small portions of the lunar surface greatly magnified, and is thus enabled to see the craters and other details in their natural proportions. To get the best

effect he uses positives printed on glass and moderately illuminated before a specially arranged background. The details are set forth in a small pamphlet* which may be advantageously studied by any one who cares to employ the new method.

It will be observed that the stereoscopic method gives the shapes of lunar features in terms altogether independent of those afforded by telescopic observation. The data furnished by the telescope serve through the principle of shadows; the data of the spectroscope serve through the principle of optical parallax. In the stereoscopic view light and shadow join with local color in defining points and spots, and all points are thrown into proper relation through their parallaxes.

G. K. GILBERT.

A FURTHER STUDY OF THE UNIT SYSTEM OF LABORATORY CONSTRUCTION.

IT is desired to present a series of drawings with the necessary explanations to illustrate the practicability of designing a laboratory on a unit system. These drawings are the outcome of a somewhat careful study of the problem and of discussions with a number of experienced laboratory administrators. They seem to me to demonstrate the entire possibility of constructing a laboratory upon the unit system.

In a previous article, which was published in the *Philadelphia Medical Journal*,† it was maintained that the unit system of Laboratory construction offers real and very great advantages. The advantages are architectural, administrative and for the work of instruction.

The architectural advantages are those of facility and flexibility of design, and those of convenience and economy of construction. It is evident that if the essential requirement is to provide a number of rooms of uniform and moderate size, abundantly lighted and conveniently accessible, then an architect has a comparatively simple problem, which may be carried out in a great variety of designs, and may be readily adapted to special situations and conditions. Such a requirement leaves an architect great freedom as to the exterior of the building, which generally seems as important to the architect as the interior arrangements are important to the owners and users of a building. One indispensable exception to the exclusive adoption of the unit rooms will recur, in probably every case —namely, that of lecture rooms. As regards the construction, I am informed that it would cost less for a building on the unit plan than for one of equal capacity but with rooms of the customary irregularity of size.

The advantages of administration are manifold. Most valuable will prove, I think, the possibility of changing the uses to which the rooms may be put, for not only may the use of a given room for one object or another of a given department be changed, but it may be transferred wholly to a different department, for a unit room as proposed will be equally adapted to the needs of, for example, chemistry, botany, anatomy or physiology—its adaptation to the special needs of any of these sciences depending only upon the furniture put into it. Within a single department a unit room may be applied to many different uses. It will be of convenient dimensions for a class of elementary study, a smaller class of advanced students, or a still smaller number of research men, or of assistants. It can be subdivided into two smaller rooms by temporary partitions. It will be convenient for collections, for a library or reading room, or for a small lecture room. The particular use of any room can be changed

* De l'emploi des photographies stéréoscopiques en sélenénologie. Extrait de l'annuaire de l'Observatoire royal de Belgique pour 1901. 27 pages.

† Vol. VI., p. 390, Sept. 1, 1900.

at any time by moving the furniture from one room to another. Another administrative advantage will be the ease with which the laboratory may be enlarged by adding a few more unit rooms, each of which will be as perfectly suited to all the varied requirements of the laboratory as the rooms already in use. Such enlargements may be indefinitely repeated as long as the building space holds out.

The advantages of instruction are those which ensue from having the students divided into small sections. These were considered in the previous article, reference to which has been made above. I venture to repeat what was there said. There are two principal alternatives between which we may choose—the adoption of large laboratories or of a series of small laboratories. The choice is between keeping the students in large classes and dividing them into small sections. Personally I can advocate only the latter choice and must plead for it very strongly. In a large laboratory with 75 or 100 or more students, the noise and confusion are necessarily great, and the detailed supervision of the work is extremely difficult. If the students are subdivided into small sections, these and other difficulties at once vanish, and if each section can be assigned a separate room it may be put under the charge of a special instructor, who shall be personally responsible for the work of that section. Thus each assistant can be given a certain independence. The sense of opportunity with the accompanying responsibility will tend to improve the quality of his teaching. He can be directed to carry his section over a certain part of the subject in a given time and left free to accomplish the result. If the section is small enough the work can be interrupted for an explanation, a direction or a quiz, and the students will ask more and better questions than in the large laboratory, where the many listeners embarrass them, and where they may not find always the same instructor at hand. Finally, the instructor can learn the personal qualities and needs of the men in a small section and establish personal relations with the individuals. It should never be forgotten that such personal relations are most important factors in efficient teaching. It might be urged against the position here taken that the class could be divided into sections in a large room, but my experience convinces me that such a scheme is utterly impracticable. The advantages of moderate sized rooms for all advanced work and for investigations of every kind are so commonly admitted, that their justification by argument is uncalled for. The unit rooms should be therefore of suitable size for these purposes also.

Assuming now that the unit system is desirable, we pass on to the consideration of what may be the best dimensions. The problem resolves itself into three questions:

First, What is the best unit space to allow for each student?

Second, What is the most convenient maximum number of students to assign to a single room?

Third, What additional space must be provided in each room for passages, sinks, shelves, etc., so as to permit it to be fully equipped for the class work?

Let us now consider these questions in the order given.

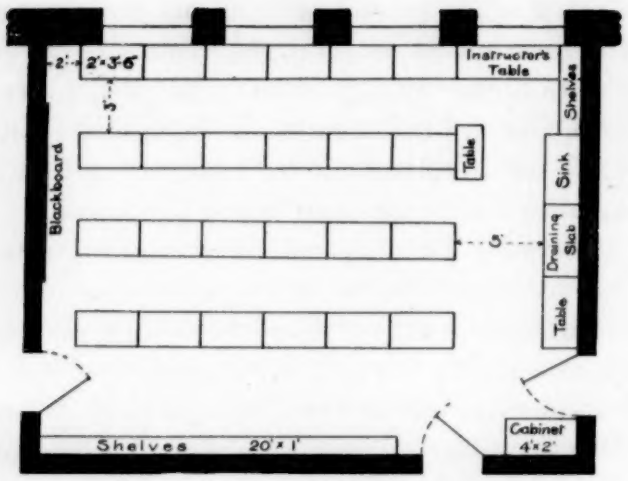
First. The unit space required for each student. In the previous article twenty square feet was suggested as a preliminary estimate, or an area four by five feet. Since then a number of laboratories have been measured, and the relative advantages of various unit areas considered. It is of course desirable on the one hand to reduce the space reserved for each student in order to reduce the total size of the building required, and on the other hand to give each student ample room to carry on the prac-

tical laboratory work under favorable conditions and without interference from his neighbors. These somewhat contradictory requirements may, it seems to me, be reconciled. The study of the subject has led to the final proposition that we accept as the *unit space three feet six inches by five feet* (3 ft. 6 x 5 ft. 0).

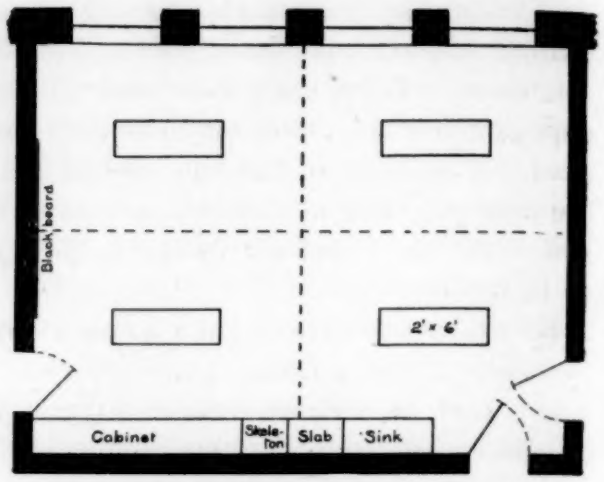
By the metric system such a space would measure 1.067 x 1.524 m., or roughly 1.01 x 1.50 m. These values suggest the possibility of adopting one meter by one and one-half as the unit space. In our space there can be put a table measuring 3 ft. 6 x 2 ft., leaving 3 ft. 6 x 3 ft. clear space for the student to sit or stand at his work, and for the instructor or others to pass behind him. The table will be long enough to permit having, say, two drawers and a locker below them, making on one side a tier about a foot wide, and still leaving space for the student to sit comfortably at the table. There are doubtless many laboratories in this country in which less space is assigned to the individual student than is here advocated, but it seems to me that such crowding and cramping immediately lowers the quality of the teaching and the quality of the studying done. The bad result is due in part to the sheer discomfort of the conditions, but is chiefly due to the inferior opportunities which such crowding entails. When students are close together there can be but little room for laboratory apparatus, consequently the practical work for the students must be to a large extent made ready for them beforehand, so that what should be a laboratory exercise at once becomes barely more than a demonstration. If the students are not crowded, then each one may be supplied with a set of apparatus and be afforded an opportunity to perform himself the complete series of operations necessary to obtain and render available the material or phenomena he is to study. A true laboratory experience is thus placed within his reach, and the instruction is changed from the lower to the higher type. It may be said, therefore, that a fundamental pedagogical principle is involved in refusing to adopt a smaller unit area than above proposed.

Second. The convenient maximum number of students in a single room. This number it is very difficult to determine. It is essentially a question of experience and judgment, and as such, the question is inherently impossible to answer in a conclusive scientific manner. I can therefore only express my opinion that twenty-four is such a convenient maximum number. This opinion is based partly upon general considerations, partly upon an examination of the special requirements of medical instruction. Apparently the common American practise, where large elementary classes are taught, is to provide instructors about in the proportion of one to every twenty-five students more or less. In some universities, where the endowments are ample and the classes moderate in size, the proportion of students to each instructor is less, even in a few cases considerably less. In many universities, on the contrary, the opposite is true. A thorough study of the proportion as it actually exists in the various American institutions of higher instruction would be a valuable contribution to the discussion.

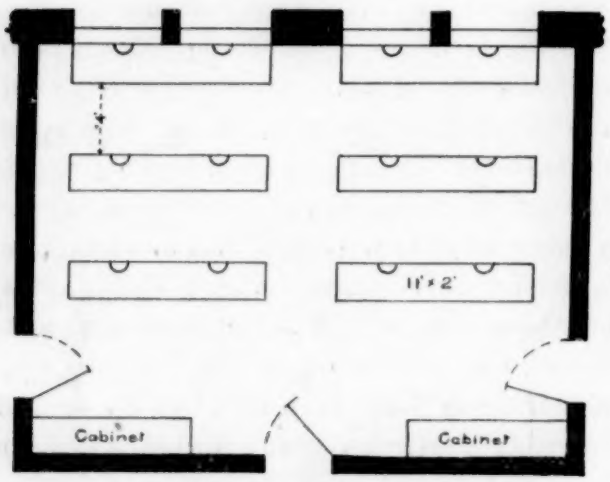
So far as I am aware this study has, unfortunately, still to be made. As regards the particular needs of medical instruction—and it is with this that I am personally most directly concerned—there are special conditions, which greatly facilitate the determination of our convenient maximum. The special conditions, alluded to, are furnished by the work of the dissecting room, because six students are assigned commonly to each subject, hence six forms a natural group in medical studies, and the number put in one room should be a multiple of



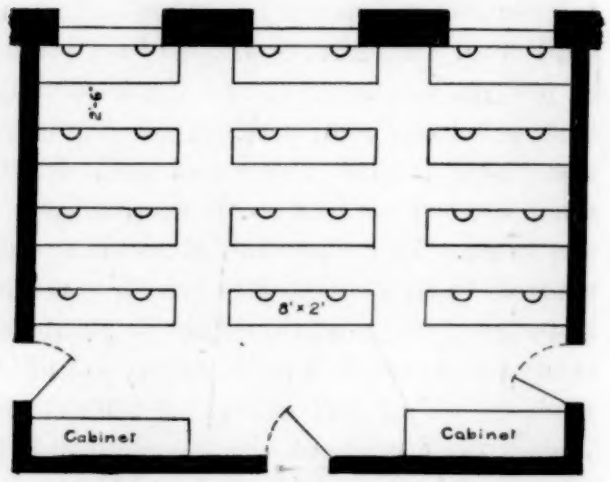
Histology



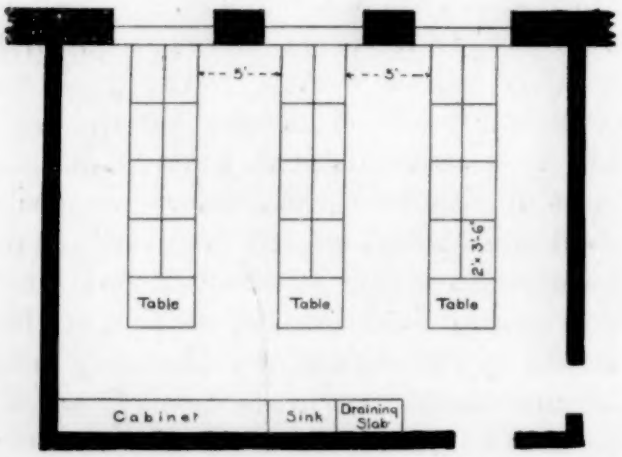
Anatomy



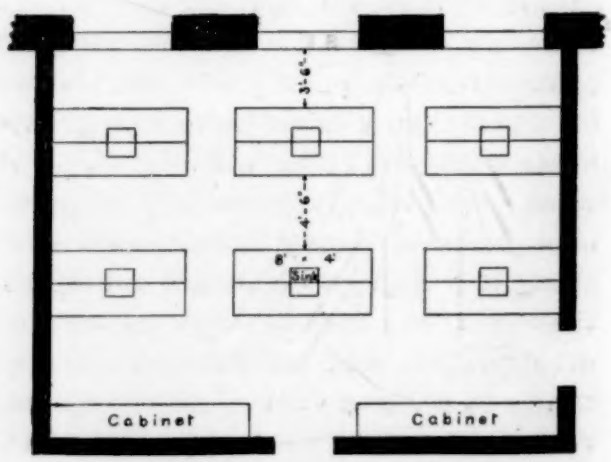
Physiology



Chemistry



Zoology



General Chemistry

six. This leads at once to the number twenty-four, four subjects in one room being convenient and having the advantage of allowing the room to approximate to the square form, which would not be practicable if the number of subjects be fixed at three or five. Twenty-four is close to twenty-five, the approximate number first determined, and being an even number it permits the formation of pairs, which has been found advantageous for certain kinds of laboratory experimental instruction. It appears also that this number commends itself to various professors, who have been consulted as heads of laboratories for histology, physiology, chemistry and pathology. While, therefore, no number can be asserted to be best, it is probably safe to accept twenty-four.

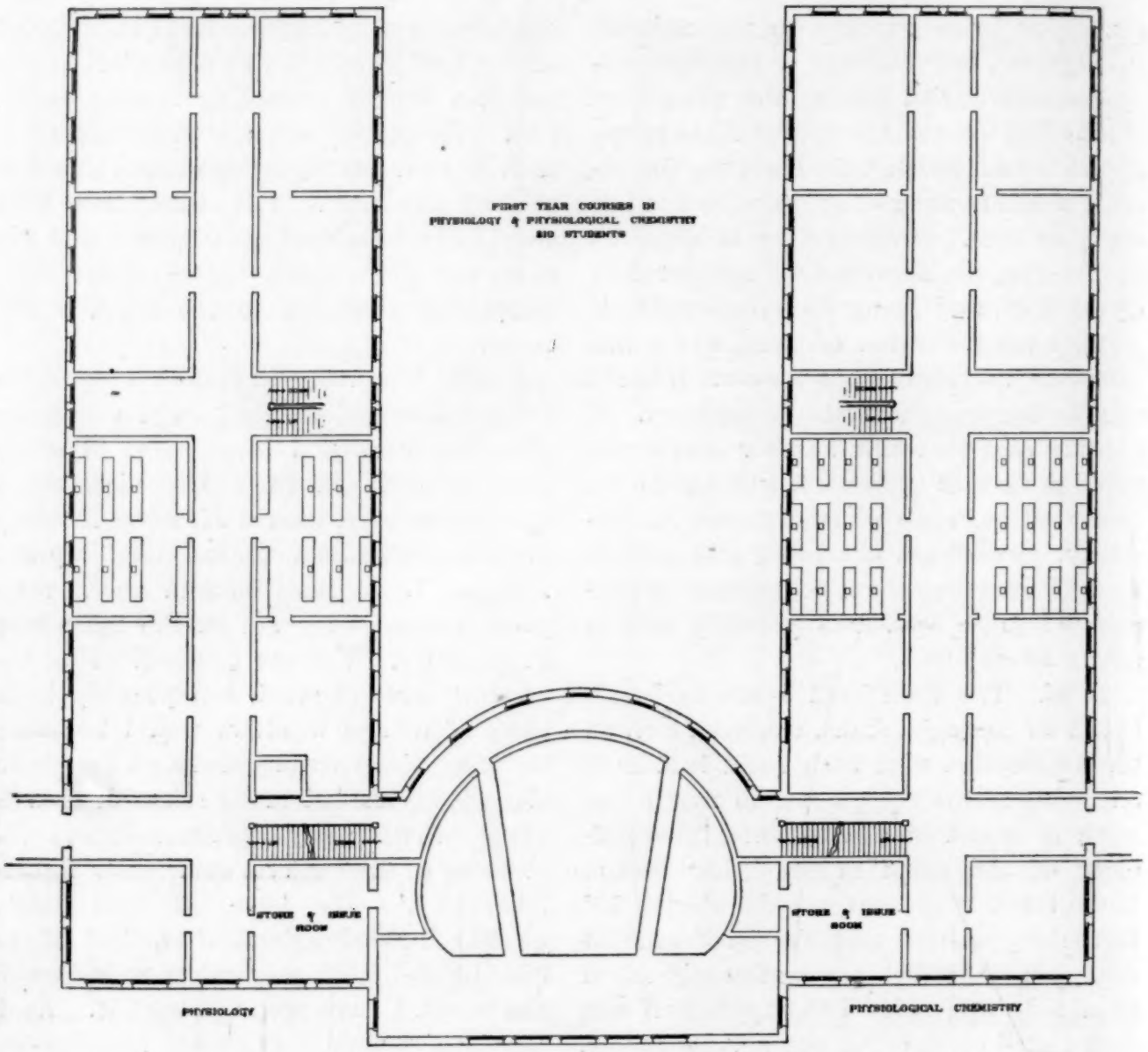
Third. The additional space to be allowed for passages, sinks, cabinets, etc., on the assumption that each room is to have an independent equipment, so that classwork in it can be carried along independently of the work in the other rooms. Measurements of several laboratories led to the supposition that for each student some ten or twelve square feet additional should be allowed. The supposition was then tested by drawing out several rooms, with varying dimensions, with detail plans of the arrangement of the furniture and fittings, until finally eleven square feet was fixed as a desirable allowance.

We are now in a position to calculate the desirable floor area on the following basis: There are to be twenty-four students in each room. Each student is to be allowed for his own use a space 3 ft. 6 by 5 ft., or $17\frac{1}{2}$ square feet, or in all 420 square feet, each student also should be reckoned to require eleven square feet additional for the general use, or in all 264 square feet. Thence $420 + 264 = 684$ square feet required for a room.

A room measuring 30 feet by 23 contains a floor area of 690 square feet (about 10.67 meters by 5.20 m.), which is almost exactly the area desired, exceeding it only by six feet. Rooms of other dimensions have been drawn, but the propositions adopted seemed the best. The thirty-foot side should of course have the windows, and the narrower dimensions, twenty-three feet, correspond therefore to the depth of the room.

I offer herewith six studies of possible arrangements of the *unit room* which the preceding discussion establishes. The six plans are for convenience, though somewhat arbitrarily, named *Histology*, *Anatomy*, *Physiology*, *Chemistry*, *General Chemistry* and *Zoology*. Little need be said about these plans, because they are in the main self-explanatory. Various dispositions of the windows are indicated, but possibly three pairs of double windows would be better than any of the arrangements on the plans. Experience has led many scientific men to doubt whether any architect knows the meaning of the term 'a sufficiently lighted laboratory.' We have all seen inadequately lighted laboratories, but if an over-lighted laboratory exists anywhere in the world, I have yet to hear of it. As to the doors, it may be suggested that, in order to provide for a future possible subdivision of the room, the wall should be so built as to allow two doors, one towards each end of the room; one door space might be built up until needed. Doors are indicated by which adjacent rooms are directly connected. It might be preferable to arrange the rooms in pairs, as indicated by the distribution of the doors in the plans for *general chemistry* and *zoology*.

In *histology* the students are placed in four rows of six each, and a special table is provided for the instructor; a large blackboard is called for on one wall, where it can be easily seen by all the students from their seats. The front edge of a table



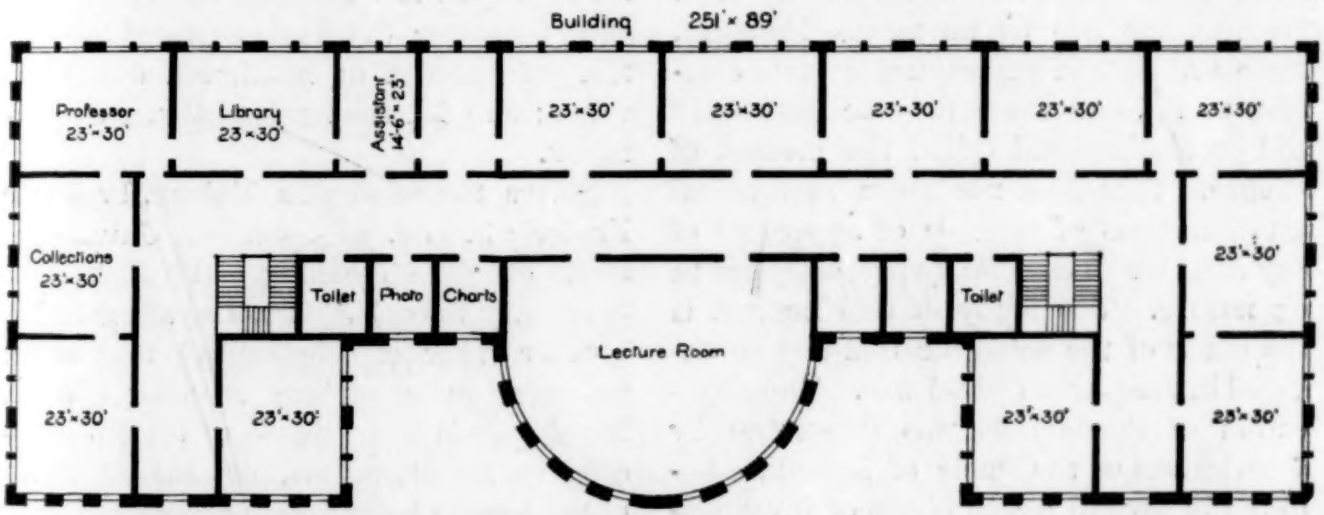
STUDY FOR FIRST FLOOR PLAN OF PHYSIOLOGICAL INSTITUTE BY W. T. PORTER.

in the fourth row is only fifteen feet from the windows. Every student will be able to obtain unobstructed light for his microscope, especially if the windows are high enough. In *anatomy* there are four dissecting tables, a blackboard, cabinet, sink, etc. In *physiology* the students are assumed to work in pairs, two pairs at each table; hence the design shows six long tables, with a separate sink for each pair of workers. In *chemistry* the tables are eight feet by two, with a separate sink for each student; as the men usually work standing, the tables are placed closer together, and since two students are calculated to a table, twelve tables are provided. The whole or part of one of the spaces marked 'Cabinet' in this plan, as in *general chemistry* may be made into a hood. *General chemistry* shows the more usual grouping of the chemical desks. back to back, with one sink for four desks. Finally *zoology* shows an arrangement which is preferred by many, the tables forming rows at right angles to the line of windows. In many respects this arrangement is favorable. A special advantage is that, without overcrowding, it permits the addition of three tables, upon which appa-

ratus may be placed which is rather for general and common than for personal use.

A candid examination of these six plans will, I hope, convince the reader that the proposed unit-room provides thoroughly convenient, but not excessive, accommodations for twenty-four students, and that the students may be distributed in many differing ways, according to special needs. It has not seemed worth while to pursue these plans further, with a view of showing how a smaller number of advanced workers could be disposed. The solution of such a problem is so simple as not to require illustration. If such a room is to be used for a collection, two cases could be arranged along the side wall, and if there are three windows, two sets of double cases could be placed against the space between the windows and run into the room as do the double rows of tables in the *zoology* plan.

In conclusion, attention is asked to the two studies for a floor plan. The first study is by Professor W. T. Porter, of the Harvard Medical School, to whose generous courtesy I am indebted for the opportunity to publish the plan for the first time. In this study the unit size adopted is 20 x 30 feet, but I have Dr. Porter's permission to state that he considers 23 x 30 feet preferable. In this study there is a central large lecture room connected with the main building, and there are two symmetrically placed wings, which, building space permitting, can be indefinitely extended, whenever enlargement shall become necessary. The second study, by myself, is merely a modification of the first: the size of the unit room is 23 x 30 feet, one room being drawn subdivided for assistant's use; the main building has been lengthened in order to provide small rooms near the lecture hall, and to increase the distance between the wings so as to secure better light; in order not to increase the floor space the wings are drawn shorter. Neither of these studies is to be regarded as more than a preliminary sketch, which needs competent revision and modification by a professional architect before it can become practically available. They suffice, however, for the purposes of this article and to illustrate the construction of a laboratory upon the unit system.



CHARLES S. MINOT.

HARVARD MEDICAL SCHOOL, BOSTON,
February 18, 1901.

THE NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

THE fifth annual meeting of the Association was held at the University of Rochester, on Friday and Saturday, December 28 and 29, 1900, about two hundred members and others being in attendance. The

officers for the meeting were Charles Wright Dodge, University of Rochester, president; Albert P. Brigham, Colgate University, vice-president; O. C. Kenyon, Syracuse High School, secretary-treasurer.

After brief remarks by the retiring president, LeRoy C. Cooley, of Vassar College, an address of welcome by President Rush Rhees, of the University of Rochester, and the introduction of the president-elect, the opening address on 'The Method of Science and the Public Schools' was delivered in the general session by Professor S. A. Forbes, of the University of Illinois. The speaker held that while the methods of study pursued by the chemist, the physicist and the biologist in their various fields of investigation are by no means identical, there are certain underlying features common to all, and these may be abstracted and generalized and called the method of science. This does not mean mechanical manipulations of tools or of apparatus of any sort, but is essentially psychological in its nature. The study of this method is the study of the scientific mind while engaged in the pursuit of science. The application of the method was illustrated by descriptions of the mode of procedure followed in several recent pieces of investigation. The paper criticized much of the present science teaching in the schools as being unsuited to train the mind of the pupil in the mental operations of independent observation, classification, generalization, deduction and experiment which are the essential features of the scientific method.

The section meetings began on Friday afternoon. In the section of physics and chemistry Professor Henry S. Carhart, of the University of Michigan, gave an address on 'The Place of Physics in a Liberal Education.' As one of the oldest and most fundamental of the sciences, physics should have a prominent place in a general plan of liberal education; its intrinsic interests make it attractive to those who study it; its laws are capable of exact quantitative statement, and it thus furnishes, with the reasoning involved, an excellent instrument of education; its applications to practical and every-day life are so numerous and so important that every intelligent citizen should have a good general knowledge of the subject; it ought, then, to be a part of every high-school course.

Following the paper, Professor Edward L. Nichols, of Cornell University, described a number of devices useful for demonstration purposes in physics. These were (1) an apparatus for showing, in a semi-quantitative way, the expansion of air at constant pressure; (2) floats adjusted to show the phenomenon of maximum density of water; and (3) the torsion balance electrometer.

Before the section in biology, Professor Frederic S. Lee, of Columbia University, spoke on 'The Teaching of Physiology in Secondary Schools.' Dr. Lee advocated a broader view of the subject than most teachers in secondary schools possess. Physiology is the science of the life processes in all organisms, not merely those of the human body. As the basis of all are the vital functions of protoplasm, and of these the pupil ought to have a clear conception. Plain distinctions should be made between gross and minute anatomy on the one hand and physiology on the other, and only so much of structure should be taught as will serve to elucidate function; the idea of physiology proper must be kept paramount. Instruction by practical experiments performed by the pupil or, failing this, demonstrations by the teacher was urged. The number of good laboratory manuals suitable for use in seconday schools now makes such a method entirely feasible. Physiology should follow physics and chemistry in the curriculum. Teach-

ers were urged to inform themselves as to the true status of the alcohol question since most of the statements in the text-books are misleading.

In the same section Professor W. J. Beal, of Michigan Agricultural College, read a paper on 'How shall a Young Person Study Botany?' The paper opened with a very interesting account of the reader's experience as a pupil of Agassiz and of Gray—"The work with Agassiz helped me more than that of any other teacher with whom I ever came in contact, and yet no teacher ever told me so little." The paper advocated the study of plants rather than the study of books about plants; the examination of many related species instead of so many isolated 'types.' The use of the compound microscope ought not to be learned until the latter part of the course. The formation of an herbarium was discouraged. The paper contained a list of most suggestive and interesting topics for individual work for beginners.

Professor W. M. Davis, of Harvard University, addressed the earth science section on 'Practical Experiments in Physical Geography.' Laboratory work for demonstration purposes is most important in this subject, and schools should have proper facilities for it, including sufficient room for practical work, flat roof for sky observations, basement room for experiments with earth and water, as well as an abundant supply of models and charts. The schedule of daily work should be so arranged as to provide for these practical exercises, just as in physics and chemistry. The exercises should include the study of the earth as a globe, the atmosphere, the oceans and the land. The study of the land must be of a kind which will lead pupils to understand what they see in a landscape. Geography ought to serve some other purpose than the education of post-office clerks and express messengers. The study should extend through successive school years, and the speaker suggested that a committee of members of the Association plan a course in the subject to extend through as many years as seem suitable. Stress was laid upon the proper training of the teacher. The preparation of local guides for field work was strongly urged.

The 'Significance and Limitations of Nature' was discussed in the section in nature study by Professor Stanley Coulter, of Purdue University.

Dr. Henry A. Kelly, of the Ethical Culture Schools in New York City, spoke on 'Synthetic Nature Study.' The object of nature work is to interest the child in natural objects and phenomena rather than to give him definite courses in elementary science, to develop a sympathetic appreciation of living creatures and to encourage habits of observation and comparison. Too great emphasis is placed upon analysis in much of our school work, especially in the object lessons. More attention ought to be given to synthetic, creative work. This end may be accomplished by selecting for study topics which are naturally related. Productive results are often obtained by combining nature study with the work in literature.

After the section meetings a general session was held to listen to a discussion of the question, 'What does the College Instructor wish the Scientific Student to know and to be able to do when he enters College?' The speakers were Professors Nichols and Carhart for physics, Coulter for biology, Beal for botany, Lee for physiology and Davis for physical geography. The trend of opinion was to the effect that unless the student could have proper instruction in methods from a competent and well-trained teacher during his high-school course, he had better enter college without any previous study of science.

The evening session on Friday was held

in the new gymnasium at the University. The members of the Association, faculties of the University, the Theological Seminary and the Mechanics' Institute, members of the Academy of Science and of the Engineering Society, together with a number of guests assembled to listen to addresses by Professor J. B. Johnson, of the University of Wisconsin, and Dr. Robert H. Thurston, Director of Sibley College, Cornell University. The former spoke on 'The Scientific Basis of Modern Industry.' By modern industry is meant the entire productive activities of the machine-using nations. Since the introduction of the steam engine the world has made more progress than in all its former history. The steam engine does as much work in a year as all the men in the land could do in a century. Without knowing the real essence of things—gravity, heat, light, electricity—we can know in some degree the laws of their action, and this knowledge is scientific. The effect of this knowledge has been to revolutionize industrial methods. Scientific education is to-day the foundation of all material prosperity, hence industrial education on a scientific basis should receive the most liberal encouragement. Germany has been the first nation to recognize the importance of this work, and now the technical schools of that country are of the same educational rank as the great universities. The applied scientist must be a specialist, and must be given facilities for investigation if discoveries are to be made which shall extend our knowledge of the forces of nature and adapt their actions to human needs.

Dr. Thurston's address was entitled 'The Citizen, his Schools, his Industries, his Life.' Dr. Thurston emphasized the increasing need of every citizen to be educated and to be aided by the State to secure and maintain the best possible position among his fellow men, for individual effort alone avails much less now than when competition was less severe. The material progress of a nation may be measured by its consumption of iron and steel. A better gauge of advancement is the progress of higher education as supplementary to that of the common schools, particularly the development of the modern forms of technical school and the scientific departments of our colleges and universities. A comparison of statistics shows that during the century just closed there was a parallel advance in the development of technical education, the growth of that product of industrial activity which represents permanent wealth, the increase of national wealth, both aggregate and per capita, and the wealth which is secured by the people as wages. The larger educational insitutions of this country now graduate yearly about a thousand students trained in the applied sciences. "The compulsion which has brought about this immense development of higher education has consisted of three main elements: (1) that ability attained, through increased and more widely and uniformly distributed wealth, on the part of the people, to secure higher education, which always marks such progress as we have traced in our material evolution; (2) that constantly growing demand for more generally learned men in the professions, including now the constructive professions; (3) that constantly growing and increasingly intense demand, in all industrial vocations, for a scientific basis for all industries and for highly trained, learned men in all great enterprises and in every system of industrial production. But all these elements of the aggregate compulsion rise out of and accompany the evolution of the modern industrial system, which, in turn, is based upon that progress in civilization through the work of the inventor, the mechanic and the man of science, which is giving us such marvelous accumulations of material wealth, with all its higher accompaniments

in the realms of the sciences, the literatures and the arts, fine, useful and æsthetic." For the past thirty years the demand for mechanical engineers has been increasing at a remarkable rate and is likely to continue. The sciences will more and more become the foundation for all industrial occupations, hence, scientific education should be begun in the preparatory schools, and instruction should be given by teachers who have received adequate training. "One great mind lost to the world through lack of the higher education which it is capable of utilizing is a more grievous loss than sunken fleets. * * * One great exploiter of scientific knowledge counts for an army, for he makes effective an army, saves a country from ruin, raises a nation to previously unimagined heights, confers the comforts of the highest civilization upon the people, or gives his fellow men leadership toward hitherto unexplored realms of wisdom, knowledge and opportunity. The grandest financial expenditures by the state are those which develop new moral, intellectual and physical forces for the benefit of the nation."

After the addresses a reception was given by the Trustees of the University for the Association and guests.

The section meetings were resumed on Saturday morning. In the section in physics and chemistry John S. Shearer, of Cornell University, spoke on the 'Relation between High Schools and College Courses in Physics.' Struck by the fact that in the elementary college courses in physics those students who had received no previous training in the subject were capable of doing quite as good work as those who had taken a preparatory course, the speaker made a careful study of the average standing of the two groups of students and found that those in the second stood only about three per cent. higher than those in the first group. Among the apparent causes of this condition the following were mentioned: Formulæ are memorized without any clear understanding of their meaning; problems are solved by rule of three as a substitute for careful analysis; the student is carefully shielded from the real difficulties of the subject; the idea is too prevalent that physics pertains only to the class-room and the laboratory and has no connection with actual affairs; the habit of self-reliance in testing things by experiment and by deduction from known laws is not developed. In a word, poor teaching is at the bottom of it all.

'The Manual Training of Chemistry' was the title of a very practical paper written by Professor William E. Bennett, of the Rochester High School. The manual training of the trade school is purely utilitarian. It aims to develop manipulative skill to the point of being automatic or reflex, while in the larger and better sense such training should also stimulate mental activity and equip the student to cope with unexpected difficulties. This he can do only if he understands the reasons for each step in the progress of his work. Chemistry, with its delicate operations and manipulations was claimed to be one of the best disciplines to develop the faculties involved.

In a paper on 'The Relative Value of the Qualitative and the Quantitative in Laboratory Work,' Professor W. C. Peckham, of Adelphi College, Brooklyn, held that the greater part of laboratory work in physics should be quantitative in character and that the deductive method of presentation is preferable in high-school work.

Dr. Henry R. Linville presented in the section in biology a paper entitled 'The Framing of a Course in Biology for Untrained Minds: a Discussion of Principles.' The writer stated what he considered should be the main features of such a course and described the work planned for the boys from the 'East Side' in New

York City, outlining the course of study and method of work in zoology in the De-Witt Clinton High School.

'Zoology in Secondary Education' was discussed by Professor Jacob E. Reighard, of the University of Michigan. Professor Reighard held (1) that science teaching in secondary schools should have for its object the developing of scientific method (intellectual) rather than the imparting of information, and that it should be disciplinary rather than technical; (2) that biology does not resolve itself in the final analysis into physics and chemistry; that it is a distinct science with its own principles, and that its intellectual methods are therefore distinctive and different from those of physics and chemistry; (3) that the intellectual methods of the biological sciences are like those employed in the historical, social and other humanistic sciences; (4) that properly conducted biological work in secondary schools therefore affords the best possible training in those intellectual methods which are of the most value to the future citizen, for it trains for citizenship; (5) that the biological sciences are homogeneous, in the sense that there is no necessary sequence of parts, and, aside from practical considerations, their study may be taken up at almost any part and pursued in any order of parts. The paper also dealt with the question, What biology is it possible to teach in secondary schools, and what parts of the subject are of highest training value?

In the earth science section Professor F. M. McMurry, of Teachers College, Columbia University, spoke on 'Controlling Ideas in Geography Work in the Grade,' maintaining that the basal units of geography ought to be taught far more fully than has heretofore been the case, that the proper presentation of these units calls for numerous excursions and the type treatment of topics, that the latter provides for far more frequent and effective reviews than have been customary, and that there is an extensive causal sequence in geography, the beginning point being physiographic and climatic conditions.

Professor Albert P. Brigham, of Colgate University, followed with an address on 'The Personal Equipment of Teachers of Geology and Geography.' The teacher should feel genuine interest in his work and ought to have had as much field experience as possible, including detailed and careful observation and description. Verification in the field of the results obtained by others should also be practised. The acquirement of full knowledge of some one phase of the subject is highly desirable. The economic bearings of the subject ought not to be neglected. Acquaintanceship with other workers in the same field is to be cultivated, and attendance at meetings of scientific societies should be both a duty and a pleasure. The teacher needs also to possess a well-selected library and to be familiar with its contents.

The last paper in the section was by Professor Amos W. Farnham, of the State Normal School, at Oswego, on 'The Purpose of Geography.' It is the purpose of geography to take into account all those physiographic elements, in a related way, which are of use to man, and those, also, which hinder his progress. The child regards the various earth forms of his environment as sources of enjoyment and of interest. Later, he learns the economic importance and the physiographic effect of climatic changes, rainfall, the flow of streams, the amount of sunshine, the effects of drought and so on. Geography cultivates the pupil's intellectual processes, stimulates his emotional nature, and leads him to realize man's dependence upon, as well as to understand his control over, the forces of nature.

In the nature study section, E. Howard Eaton, of the Bradstreet Preparatory School

for Boys, Rochester, spoke on 'Birds in Nature Study.' The rapidly increasing study of birds and bird-life is due, in part, to the general awakening of interest in nature; but there is also a wide-spread feeling that the number of our native birds is decreasing very rapidly, and that it is only by instructing the rising generation in the value of birds and the ways of protecting them that we can hope to preserve the varied, beautiful and highly beneficial species which are disappearing before the onward march of railroads, telegraph wires, plate-glass windows, electric lights, milliners, wood-choppers, ditch-diggers, English sparrows, murderous boys and untutored men. There is, moreover, a great inherent value in bird study. Children are interested in life, and birds are the most alive of all animals. Their highly specialized structure and life activities, their motion, song, language, arts, architecture, community interest, travel and personal traits are highly suggestive to the youthful mind. In this department of nature study there is also a chance of directing the dawning moral sentiments which can not be neglected. To tell children that life is sacred and that nothing that lives should be killed is weakly sensational, irrational and insulting to the ruler of the universe. Boys should be taught why, when and what to kill; not never to kill. The teacher of bird study must know not merely technical biology, but also the natural history of birds, and teach the general structure, relations, habits, food, song, flight, and special adaptations of the different families of birds and the common individuals of each family. Let the boys and girls become acquainted with our bird neighbors and their occupations, and when they know them as well as they do their own friends and recognize them as easily, then they will be good bird protectors.

Mrs. Anna Botsford Comstock, of Cornell University, discussed the subject of 'Nature Study and the Grade Teacher,' describing the work being done in the State in the way of introducing nature study into the schools and mentioning the difficulties encountered in getting the work properly started, owing to the lack of preparation on the part of the grade teachers.

At the closing general session Professor Frank Carney, of Keuka Institute, presented a paper on 'The Moral Value of Science Studies,' and John W. Spencer, of Cornell University, described 'The Work of the Junior Naturalists' Clubs.' These clubs are composed of boys and girls in various parts of the State and were started for the purpose of developing interest in nature. The membership now includes several thousand.

At the business meeting with which the session closed it was announced that forty new names had been added to the membership roll and that the financial condition of the Association was satisfactory. The following officers were elected: *President*, Professor Franklin W. Barrows, Central High School, Buffalo; *Vice-President*, Professor Frank M. McMurry, Columbia University; *Secretary-Treasurer*, Professor A. R. Warner, High School, Auburn.

After adjournment many members took the opportunity to visit Ward's Natural History Establishment, the works of the Bausch and Lomb Optical Company, the Eastman Kodak Company and other places of interest.

Exhibits of scientific apparatus, museum and laboratory supplies, charts, etc., were made by Bausch and Lomb, Ward, Marine Biological Laboratory, Denton Brothers and others.

The proceedings of the meeting will be published in full by the Regent's Office in Albany.

CHARLES WRIGHT DODGE,
Secretary.

SCIENTIFIC BOOKS.

Knowledge, Belief and Certitude, an Inquiry with Conclusions. By FREDERICK STORRS TURNER, B.A. (Lond.). London, Swan, Sonnenschein & Co.; New York, The Macmillan Co. 1900. 8vo. Pp. viii + 484. Price, $2.25.

This is a plain, straightforward bit of work, possessing the good qualities that, as a rule, mark first-hand thinking. Here and there Mr. Turner may be disposed to magnify his office in somewhat *naïve* fashion; but he is so much in earnest that one can forgive him readily.

The problem by which our author has been oppressed may be stated succinctly thus: What is Real Knowledge? In addressing himself to its solution, Mr. Turner distinguishes between what he calls 'abstract' and 'real' knowledge. He finds that the former is common to the many disciplines indicated usually by the generic names science and philosophy. In this connection he says a number of sane things about science, a majority of them, to be sure, quite familiar already. The manner in which he runs amuck among the philosophical dignitaries and their honored idols does him no small credit, if he be aware—which I do not think he is—of the enormities he commits. Some of the references to psychology look suspiciously second-hand, and the cavalier treatment of Wundt hardly reassures one regarding Mr. Turner's insight into contemporary problems and tendencies. Yet, be this as it may, our author suffers nothing on the score of tradition; and, if he contrive to annoy some few, he will, for similar reasons, amuse a great many more.

The portion of his book on which he lays the greatest store on the score of originality, is entitled 'Real Knowledge.' It may be of interest to note the precise import he bestows upon this rather optimistic phrase. For we all remember the proverb about the place where angels fear to tread. 'Real Knowledge,' then, is the "science of ends, of human causality, so far as man is a cause by his own will and according to his own design (351). * * * In all its stages the *end* both is, and leads to, real knowledge. * * * It seems to me that now in this knowledge of ends we have a full and sufficient answer to those psychologists and philosophers who call in question the reality of the first fundamental certitude, that of the Self." (361–62). Thus, knowledge of the Self is 'real knowledge.' Again, "it is not too much to say that the knowledge of our own causal power is on a level with the most certain and the most important knowledge which we possess. This is real knowledge; compared with which mathematics and metaphysics seem shadowy and unsubstantial" (386). With this the 'nescience of science' is to be sharply contrasted. "Science is not a unity nor a system, but merely a general name for a number of separate sciences. All attempts to frame a tenable theory of the universe by means of abstract objective knowledge, or science, are necessarily doomed to failure" (439). On the other hand, positive conclusions are possible, to wit: "The first positive conclusion we have reached is that real knowledge is a state or mode of the conscious being of real living men and women. * * * The second positive conclusion is that this real knowing is a knowing of real persons, real things, real events. * * * The third positive conclusion is that the knowing and the known are united in the reality" (477–78). Such are Mr. Turner's constructive results, so impressive to him that he ends, "not with a feeling of self-complacency, but with joyful confidence in the truth that has been revealed to me (479)."

Needless to tell, all this happens to be one huge *ὕστερον πρότερον*. Mayhap, human experience must, by the very nature of the case, partake of this character. But a writer who would reveal the inwardness of 'knowledge, belief and certitude' can not be said to have solved his problem by the mere statement of a few among its obvious implications. No doubt, he may accomplish something along such a line—he may be assembling the factors involved. Just because this appears to be Mr. Turner's situation, his interesting book would serve better than some pretentious manuals as an introduction to philosophy for students whose intellectual fates had been committed to a skilled teacher. For it is not given to every author to be so frank when he sees men as trees walking.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

The Penycuik Experiments. By J. C. EWART. London, A. and C. Black. 1899. Pp. xciii + 177.

Experimental Contributions to the Theory of Heredity. A. Telegony. By J. C. EWART, Proc. Royal Soc., Vol. LXV. 1899. Pp. 243–251.

Guide to the Zebra Hybrids, etc., on Exhibition at the Royal Agricultural Society's Show, York. By J. C. EWART. Edinburgh, T. and A. Constable. 1900. Pp. 51.

About ten years ago there was an agitation in England for the establishment of an institution to experimentally test current theories regarding the processes of evolution. A memorial was circulated, and signed by many eminent persons, but the castle—or rather menagerie—in the air which enthusiasts had built did not descend to solid ground. In the meanwhile, however, certain individuals were laying plans of their own. Experiments in breeding moths had already yielded remarkable results. The experimental method had become fashionable, at least in theory, and it seemed that there were large possibilities before those who had time and money at their command. Under these circumstances it was, perhaps, not remarkable that Professor Ewart, aided and abetted by various friends, should have undertaken to breed equine hybrids to prove the validity or otherwise of the theory of telegony. But if the Penycuik experiments were thus a natural product of the times, they were for that reason the more timely, and all biologists may be thankful to the Scottish professor for having planned them so carefully, and carried them out so satisfactorily.

And now that we have the published results before us, what of telegony? The evidence on which it rested, at least so far as the Equidæ are concerned, is so thoroughly disposed of that it seems almost superfluous to discuss it. Professor Ewart did not start out with the proposition that telegony was absurd, and the statement that he would so prove. On the contrary, whatever he may have thought of the doctrine, he gave it every chance. He also got results similar to those which had been held to prove telegony. Mulatto, a West Highland pony, had a foal by Matopo, a Burchell's zebra. Subsequently Mulatto had a second foal by Benazrek, a gray Arab. This foal, which, except telegony be true, had no zebra blood in its veins, had a number of stripes when a few days old. A figure of it is given, and it certainly has a very zebra-like appearance. At this point a less scientific investigator might have concluded that telegony was proved, and there was nothing further to be said. Not so Professor Ewart. He continued his researches, and in due time was able not only to show that such striping as that of Mulatto's second foal was not uncommon in horses, but also to produce equally striped foals from mares which had never seen a zebra.

In the course of the investigation, many facts of the greatest interest were ascertained. The hybrid between the Highland pony and Burchell's zebra showed a striking likeness to the Somali zebra in the plan of its stripes. This is considered by Professor Ewart to indicate reversion, and in this connection excellent reasons are given for considering that the common ancestor of the various breeds of horses was striped, and that among zebras the Somali species is in many respects the most primitive.

The whole question of reversion resulting from a cross is carefully discussed, and it is suggested when there is a sort of antagonism between the immediate parents or close ancestors, the more or less remote ancestors might contribute more than their normal share to the new individual. That is to say, the two incompatible parents annihilate one another, more or less, like the Kilkenny cats, and the ancestral traits, which otherwise would be crowded to the wall, come to the front. This sounds reasonable enough, but one may hazard a further suggestion that the two parents would contribute the *same* latent ancestral characters, but *diverse* modern ones, and so the characters of their common ancestor might be emphasized. Thus, let A be the characters of the common ancestor, and B and C the characters subsequently acquired by the race represented by each parent. Then the union would be that of AB + AC, which would give A the advantage, if for any reason B and C were less than ordinarily powerful. Dr. Max Standfuss, in breeding hybrid moths (*Entomologist*, 1900, p. 341), has found that the phylogenetically oldest

species appear to be prepotent over those of more recent origin. This may be understood if we represent the union as AA + AB, both contributing the same ancestral characters, and one the same modern ones as the ancestral.

A very interesting point brought forward by Professor Ewart is, that in some cases reversion may lead to a sort of rejuvenescence. For instance, "If there are any puppies in a grossly imbred litter that take after a good ancestor several generations removed, they invariably prove the strongest and best." If there is any truth in the idea that in man physical vigor is correlated not infrequently with a certain rusticity of mind, it may be that the phenomenon is one of a similar kind.

T. D. A. Cockerell.

East Las Vegas, New Mexico.

Geological Survey of Canada, General Index to the Reports of Progress, 1863 to 1884. By D. B. Dowling, B.A.Sc. Ottawa. 1900. Pp. 475.

In the terms of the prefatory note by Dr. G. M. Dawson, Director of the Geological Survey, "the present General Index begins with the volume of 1863 for which an entirely new index has been made, and embraces the succeeding reports to that of 1882–83–84 inclusive. It covers sixteen volumes and two short summaries, making in all 6,585 pages of text to which more than 31,000 entries are given. It thus provides a ready means of reference to practically the entire body of observations published by the Geological Survey up to the year 1884."

From 1885 to the present time, 'Annual Reports' have been issued by the Department, each of which is separately indexed. The 'General Index' just issued forms publication No. 638, of the Geological Survey and contains 475 pages of text divided into three parts, viz:

Part 1. Districts described in the several reports.

Part 2. Special Examination.

Part 3. The General Index.

These include: (1) The reports analyzed geographically and arranged under Provinces, Counties and Districts, so that under any county or district in a province, a list of references to reports, arranged in chronological order, is given. (2) Ores, rocks, minerals or fossils, that have been subjected to assay, analysis, microscopical examination, that were scientifically described. (3) The general index of which the following are the principal points: the arrangement under a reference to a place being usually chronological, while under a subject references will be found alphabetically arranged, or in case of common occurrences, as of iron, fossil, etc., localities may be grouped under provinces.

The 'Reports of Progress of the Geological Survey of Canada' and the 'Annual Reports' of the same contain a vast amount of useful and practical information on the mineral and other natural resources of the Dominion, as do also the maps which accompany these reports, giving in a graphic form the leading geological features of the territory included. This 'General Index' is therefore hailed with delight not only by all who are interested in the resources of the great Dominion as a work which gives ready reference to the various economic products in a series of volumes containing 6,585 pages of text, but also by all students in science who may desire to carry on further researches in the various districts comprised in the reports treated. The amount of time henceforth to be saved in searching for information on the thousand and one points referred to in each of the volumes indexed cannot be over-estimated, and all persons into whose hands this index falls will bless its projector as well as author. An index to all the geological maps referred to in the Reports may be found under the word 'Maps.'

Mr. Dowling's index will also be of special value for bibliographic references, as the work performed by various officers of the Geological Survey from 1866 to 1885 falls under the name of each officer; and, as the readers of the *Ottawa Naturalist* are aware, in Vol. XIV., No. 6, of that Magazine for September, 1900, Mr. Dowling gave a chronological index to the field work done by the officers of the Survey from its commencement to 1865, so that there is now available for ready reference a complete history of geological work done in Canada from 1843, the year when the Geological Survey of Can-

ada was instituted, to the present time. The price of the above is fifty cents. Copies may be obtained from the Librarian of the Geological Survey. H. M. AMI.

THE CROTONS OF THE UNITED STATES.*

THE United States species of *Croton*, as represented in the principal herbaria of the country, have been monographed by A. M. Ferguson, formerly connected with the Missouri Botanical Garden, now at the University of Texas, whose paper, accompanied by ample analytic keys, and illustrations of all but the most commonly figured species, forms a rather thick octavo paper to constitute a part of the forthcoming 'Twelfth Annual Report of the Missouri Botanical Garden,' where the work was done. In addition to keys and synoptical headings, a citation of necessary synonymy and specimens examined, combined with short but clear descriptions, appears to ensure the easy understanding of the species of a genus that has always afforded a fair number of puzzles to the botanist.

PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE Proceedings of the 49th meeting of the American Association for the Advancement of Science, edited and published by the permanent secretary, L. O. Howard, make a handsome volume of 500 pages. The volume has as a frontispiece a portrait of the late Edward Orton, who, it will be remembered, died before he was able to give the address of the retiring president at the New York meeting. The volume contains as usual the lists of past officers, the constitution of the Association and lists of members and fellows. There then follow the address of the president, Mr. Grove Karl Gilbert, of the U. S. Geological Survey, and the proceedings of the separate sections, including the addresses of the vice-presidents. The volume concludes with the reports of the secretaries and of the treasurer. It is gratifying to note that the membership at the time of the New York meeting was 1,921, as compared with 1,695 the year before. One rather unexpected result of the change in the time of the meeting from August to June has been a delay in the publication of the volume. Immediately after the adjournment of the meeting the members separated widely for their summer vacations; those who did not go to Europe went into the field, and the secretaries of sections were among them. As a result it was impossible for the permanent secretary to get together the manuscript for a large part of the volume until after the return of the secretaries of sections and other members to their homes in the autumn. The volume was all in print, however, by December and would have been distributed before January 1st except for an accident in the bindery which again delayed the general distribution.

* Ferguson, A. M. 'Crotons of the United States.' (Printed in advance from the Twelfth Annual Report of the Missouri Botanical Garden.) Issued February 16, 1901. Pp. 41, pl. 28.

BOOKS RECEIVED.

Proceedings of the American Association for the Advancement of Science, Forty-Ninth Meeting, held at New York, N. Y., June, 1900. L. O. HOWARD. Easton, Pa., The Chemical Publishing Company. 1900. Pp. 409.

Lecithoblast und Angioblast der Wirbelthiere. WILHELM HIS. Leipzig, B. G. Teubner. 1900. Vol. IV. Pp. 328.

L'Année biologique. YVES DELAGE. Paris, Schleicher Frères. 1900. Pp. xxxi + 847.

Report of the Census of Porto Rico for 1899. LIEUT.-COL. J. P. SANGER. Washington Government Printing Office. 1900. Pp. 417.

Electric Lighting. FRANCIS B. CROCKER. New York, D. Van Nostrand Company; London, E. & F. N. Spon. 1901. Vol. II. Pp. vi + 505. $3.00.

Anatomy of the Cat. JACOB REIGHARD and H. S. JENNINGS. New York, Henry Holt & Company. 1901. Pp. xx + 498.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of the Boston Society of Medical Sciences for January 15th contains 'Notes on the Occurrence of *Anopheles Punctipennis* and *A. Quadrimaculatus* in the Boston Suburbs' by Theobald Smith, 'Notes on Anopheles' by Charles S. Minot, and 'Notes on Mosquitoes' by F. P. Gorham. E. R. Le Count presents a 'Report on the Histologic Changes found in the Tissues of Animals Inoculated with Diplococcus Scarlatinæ (Class),' stating that they differ from those noted in man by Pearce in

degree rather than character. A paper of very general interest is that on the 'Action of the Larynx in Relation to the Pitch of the Voice' by Thomas Fillebrowne showing that the larynx should *not* rise with the pitch if one wishes to retain the vocal powers. There are a series of abstracts of papers presented at the Indianapolis meeting of the Public Health Association as follows: 'Observations on Methods for the Detection of *B. coli communis* in Water' by E. E. Irons, 'Variation of the Properties of the Colon Bacillus, Isolated from Man' by W. W. Ford, 'Thermal Death Point of the Tubercle Bacillus and its Relation to the Pasteurization of Milk,' by H. L. Russel and E. G. Hastings, 'A Note on the Disinfectant and Deodorant Properties of Ammonium Persulphide,' by M. P. Ravenel and S. H. Gilliland, and 'An Inquiry into the Rôle of the Domestic Animals in the Causation of Typhoid Fever,' by W. R. Stokes and John S. Fulton.

In *The Popular Science Monthly* for March Simon Newcomb continues his 'Chapters on the Stars' this instalment being devoted to statistical studies of proper motions, concluding that, so far as we can judge, our own system is near the center of the stellar universe. R. H. Thurston considers 'The Law of Substance,' substance being what we are familiar with as 'matter.' Dudley Allen Sargent discusses 'The Height and Weight of the Cuban Teachers' who were in Cambridge last summer, showing that in these points they fall below the average of our own teachers. The reasons for this and the remedy are suggested. Hudson Maxim treats of 'Throwing a High Explosive from Powder Guns' considering that this problem and that of firing high explosives through armor plate have been successfully solved. Harold W. Fairbanks describes 'Pyramid Lake, Nevada' and its curious tufaceous formations, and William H. Hobbs deals with 'The Geologist Awheel' believing that topographical work may be greatly expedited by the use of the bicycle. 'The Formation of Habits in the Turtle' by Robert Mearns Yerkes, describes a series of experiments showing how a turtle learned, or acquired, the shortest route around a number of obstacles to its nest. In 'The Science of Distances,' being the address of the President of the Geographical Section of the British Association, George S. Robertson shows how steam and electricity have shortened the time between distant places and hints at what may be hoped for in the future. Finally Havelock Ellis continues 'A Study of British Genius,' this instalment being devoted to a consideration of the influence of birth and race. Perhaps the most interesting of the brief articles are those discussing the relations between the Government and science.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 110th meeting was held at the Cosmos Club, February 13, 1901. The following papers were presented:

Age of the Coals at Tipton, Blair County, Pennsylvania: Mr. David White.

It was shown that the coals occur in a down-faulted block of coal measure beds surrounded by Pocous strata.

Production of the B. & M. Plant at Great Falls, Montana: Mr. R. H. Chapman.

A view of the reduction works was shown and specimens of the copper products exhibited.

Notes on Two Desert Mines in Southern Nevada and Utah: Mr. S. F. Emmons.

The Delamar mine is situated on the western slopes of the Meadow Valley Range in southeastern Nevada. Its ore-body occurs in a heavy series of quartzite beds of Cambrian age, that strike in a northwesterly direction and dip 23° southeast. The so-called vein is a fracture plane whose strike varies but slightly from that of the enclosing quartzite, but its dip is 70° to 80° to the northwest, or nearly at right angles to the strata. It neither has vein-filling, nor is it mineralized to any considerable extent, but has zones or chimneys of crushed quartzite along it that have been mineralized and carry the ore values. Two granite-porphyry dikes about 30 to 40 feet in width run nearly at right angles to the main fracture, and are crossed by a narrow dike 6 to 10 feet wide of basic lamprophyric rock, so decomposed that its mineral composi-

tion is difficult to recognize. It is sometimes called 'gouge' by the miners. The main fracture plane follows this dike, generally within its walls. The principal ore-chimney is a zone of crushed quartzite around the intersection of this dike and fracture plane with the first granite porphyry dike, where it approaches most closely to the second. All the dikes show evidences of deformation since their intrusion. Smaller ore bodies are found in the hanging wall of the dike to the northward and generally only a few feet in width, while the greater ore chimney, which is divided into four parts by the intersecting and practically barren dikes, has an area of about 200 feet square in horizontal section. The ore is an intensely crushed quartzite, recemented and largely replaced by silica, so that often nothing of the original granular structure of the quartzite is distinguishable. The unoxidized ore shows, besides quartz, only a little finely divided pyrite, very little microscopic chalcopyrite and some telluride in spots. The interesting feature of the mine is the variation in the tenor of its ore, whose values are mainly in gold, the bullion being only 300 fine. In a broad general way it may be said that the values increased downwards to the 700-foot level from $20 to $40 and often to $70, to the ton, small lots running very much higher. From there downwards the values have decreased to about $6 or $8 at the tenth level, and to only $1 to $3 dollars at the fifteenth and sixteenth levels. It is evidently a case of enrichment by gradual leaching down of the precious metals, but as the country is so dry that there is never any moisture in the mine, it must be assumed that this leaching took place in an earlier geologic period, when there was greater precipitation; presumably during the Bonneville period.

The Horn silver mine, in southwest Utah, occurs in a region of very much more complicated geological structure. The Grampian Hills at the south end of the San Francisco Mountains consist of more or less crystalline Paleozoic limestone into which a monzonite mass (locally called syenite) has been intruded in stock-like form. A broad contact zone between limestone and monzonite (locally called andesite) is made up of a dark brown rock, consisting mainly of garnet with many other contact minerals, notably, a white, fibrous tremolite (locally called needle spar).

Opposite the mining hamlet of Frisco, an east and west fault has cut through limestone and monzonite, raising the latter so that it abuts against the former. Along the east base of the hills is a later fault plane, running magnetic north and south, along which more recent andesitic breccias form the hanging-wall, and limestone or monzonite, as the case may be, the foot-wall, the fault plane having a steep dip to the eastward. It is this fault plane that constitutes the Hornsilver vein. The fault fissure or zone varies in width from a maximum of 90 feet down to one or two feet, and has been opened to a depth of 1,600 feet. It is by no means all ore, but consists in great measure of crushed wall-rock, limestone or andesite, as the case may be, but so much altered that its original character is difficult to determine. The ore bodies which have been of great size were largely replacements of this material. It is well known that in its early history, about 1880 to 1885, the mine produced enormous masses of rich silver-lead ores and paid some four millions in dividends in spite of high costs of production, due to its situation in the midst of the desert.

The interesting feature to which the speaker called attention is that whereas neither copper nor zinc was recognized as a constituent of the ore in the upper levels, the main values of late years have been found in a very rich body of copper ore, largely copper glance, extending from 650 down to 750 feet. Moreover, at 500 feet, zinc minerals began to show in small amount, and now in the lower levels the largest ore masses carry 40 to 50 per cent. of zinc, with 6 or 8 per cent. of silver, it being estimated that they have 300,000 tons of this ore in sight. In the deeper part of the mine, while the fault zone holds its width in the main chimney, the ore values have shrunk below the workable point. This is evidently another instance of the leaching down and concentration into the middle levels of the mine of the more soluble salts of copper and zinc, and their reprecipitation in more or less segregated bodies.

The Asphalt and Bituminous Rock Deposits of the United States: GEO. H. ELDRIDGE.

The asphalts, by this meaning the several varieties of purer hydrocarbon compounds, such as uintaite, grahamite, etc., occur in vein form in rocks of Ordovician, Carboniferous and Tertiary ages. They are found in West Virginia, Indian Territory, Colorado, Utah and California. The most remarkable veins are in Utah near the Colorado line, where a maximum width of 18 feet and an uninterrupted length of 10 miles for a single vein have been observed. In California they occur in proximity to the developed oil fields, and the material is here of softer nature than that found in the veins of Utah and elsewhere. Where the veins occur in shales they are irregular and interrupted.

The bituminous rocks embrace both sandstones and limestones. The limestones as yet known are confined to Indian Territory, Texas and Utah; in Texas, in the upper part of the Ordovician, and in Utah, in the Green River Tertiary formation. Those of Indian Territory are conspicuous for their thickness and extent. At one point a bed of 350 feet, impregnated from bottom to top, was observed, having a lineal extent of something over two miles, with considerable variation in the thickness of the bed. Bituminous sandstones are the most generally distributed in the United States, occurring of especial richness in Kentucky, Indian Territory, and in the Coast ranges of southern California. The percentage of bitumen contained in these rocks varies up to a maximum of 14 in the limestones and 20 in the sandstones.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 335th meeting was held on Saturday evening, February 23rd.

Under the head of notes, B. W. Evermann spoke of the aquatic vegetation observed during the winter at Lake Maxinkuckee, Ill., saying that it remained green and flourishing at a late date. The manner in which the reproductive buds were formed on the species of *Potamogeton* and *Valisneria* was described, and it was stated that it was these buds of the wild celery that were sought after by the coots and ducks.

W. H. Ashmead stated that the examination of the Hymenoptera collected by Trevor Kincaid of the Harriman Alaskan Expedition had raised the number of species known to occur in Alaska from 28 to 318, 195 of which were new. Four European species were noted for the first time as occurring in Alaska, while 30 of the genera had never before been reported in North America.

E. L. Morris exhibited photographs of four new species of *Plantago* stating that these pictures, which were remarkable for their distinctness of outline and detail, were for the purpose of supplying the U. S. National Museum with accurate figures of types which belong to other collections.

F. A. Lucas described 'A Fossil, Flightless Auk' obtained at Los Angeles, Cal., from beds stated by Mr. Dall to be of Upper Miocene, or Lower Pliocene age. The bird was represented by only the proximal part of the humerus, but this showed it to have been somewhat less in size than the Great Auk and more highly specialized, the humerus being shorter, more flattened and more curved, with sharper muscular ridges than the corresponding bone in that species. The name *Mancalla californiensis* was proposed for the fossil auk, and its nearest living relative stated to be the California Murre. The specimen will be described in detail in the Proceedings of the U. S. National Museum.

W. P. Hay presented a paper 'On the Distribution and Classification of the North American Crayfishes' giving first a brief review of the classification of the Astacoidea in which four families were recognized—Eryonidæ, Homaridæ, Parastacidæ and Astacidæ In the Astacidæ the three genera *Astacus*, *Cambaroides* and *Cambarus* were described and their distribution commented on.

The American species of *Astacus* and *Cambarus* were then taken up and a few points on the life history of these animals were given. It was stated that the five groups of Faxon are natural and well marked and are worthy of subgeneric rank at least. Contrary to Dr.

Faxon's belief, the author contended that the fifth group of crayfish, including southern United States and Mexican species, is the most generalized and resembles Cambaroides most closely. This would seem to indicate that the theories of Huxley and Faxon to explain the distribution of the Astacidæ will not hold good and that the original home of the Astacine progenitors was in southern seas and invaded the continents from that direction. It was further stated that the specialization of *Cambarus* is probably much more ancient than the specialization of *Cambaroides*, and that the resemblance between *Cambaroides* and *Cambarus* is accidental and does not indicate a close relationship.

M. B. Waite spoke of the 'Influence of Vegetation on the Sand Formations of the Michigan Lake Shores,' his remarks being illustrated by lantern slides. He showed how dunes may originate by the sand being at first held in check by grass, which grows upward and outward as the sand accumulates, and illustrated the gradual progress inland of dunes and the manner in which the sand moved slowly forward in great waves to overwhelm the adjacent country.

F. A. LUCAS.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 530th meeting of the Society was held February 16, 1901. Mr. R. H. Strother called attention to the fact there are now three processes of making phonographic records that promise to be permanent, so that the early idea of making records of speech for posterity now seems feasible.

Mr. R. A. Harris read a paper entitled, 'A Few Questions in Hydrodynamics.' This reviewed briefly the kinds of problems in liquid wave motion which have been considered in articles and treatises on hydrodynamics. But its chief object was to point out the lack of attention given to oscillations in bodies of water having incomplete boundaries, although a somewhat analogous subject, viz., that of the open organ pipe, had received much attention. The behavior of water in straits is also a neglected subject. The case treated by Airy really applies only to motions in straits not extremely short, and where the bodies connected are comparatively deep. These and other hydrodynamical questions, it was contended, must be investigated before satisfactory progress can be made in the theory of tides.

Mr. J. F. Hayford presented the 'Recent Progress in Geodesy,' referring to the triangulation in progress on the 98th meridian; the connection of the principal United States and European stations by pendulum observations; the connection recently made between several independent systems of precise levels, so that the elevations of some 4,000 places have now been published; and the results of the calculations of the axes of the terrestrial spheroid based on the United States observations. [This paper appeared in SCIENCE for March 8th.] A spirited discussion followed regarding the accuracy of the new and rapid base-line measurements, and the leveling between the Gulf of Mexico and the Atlantic Ocean.

CHARLES K. WEAD,
Secretary.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, February 23, 1901. About thirty persons attended the two sessions. The President of the Society, Professor Eliakim Hastings Moore, occupied the chair. The following persons were elected to membership: Professor John F. Downey, University of Minnesota; Professor F. C. Ferry, Williams College; Mr. H. T. Gerrans, M.A., Oxford University; Mr. Edwin Haviland, Jr., New York City; Professor A. E. H. Love, Oxford University; Mr. V. R. Thyagarajaiyar, Bangalore, India. Two applications for membership were received.

The following papers were presented at this meeting:

(1) Dr. H. E. HAWKES: 'Note on Hamilton's determination of irrational numbers.'

(2) Professor E. B. VAN VLECK: 'On the convergence of continued fractions with complex elements.'

(3) Dr. M. B. PORTER: 'On linear homogeneous finite difference equations, with applications to certain theorems of Sturm.'

(4) Professor L. E. Dickson: 'Concerning real and complex continuous groups.'

(5) Professor E. O. Lovett: 'An application of continuous groups to non-euclidean geometry.'

(6) Professor E. O. Lovett: 'Contact transformations which change asymptotic lines into lines of curvature.'

(7) Professor H. B. Newson: 'Indirect circular transformations and mixed groups.'

(8) Mr. W. B. Fite: 'On metabelian groups that cannot be groups of cogredient isomorphisms' (preliminary communication).

(9) Dr. Edward Kasner: 'On algebraic potential curves.'

(10) Professor Maxime Bôcher: 'Green's functions in space of one dimension.'

(11) Dr. H. E. Hawkes: 'Estimate of Benjamin Peirce's linear associative algebra.'

(12) Dr. G. A. Miller: 'On holomorphisms and primitive roots.'

(13) Dr. Edward Kasner: 'Theorems on collinear lines in space.'

(14) Mr. C. W. M. Black: 'Decomposition of a form in n variables in an arbitrary domain with respect to a prime ideal modulus.'

(15) Professor Maxime Bôcher: 'An elementary proof of a theorem of Sturm.'

(16) Dr. L. P. Eisenhart: 'Surfaces whose first and second fundamental forms are the second and first respectively of another surface.'

(17) Dr. L. P. Eisenhart: 'Possible triply asymptotic systems of surfaces.'

(18) Dr. H. F. Stecker: 'On the determination of surfaces capable of conformal representation upon the plane in such a manner that geodetic lines are represented by algebraic curves.'

(19) Professor Maxime Bôcher: 'Non-oscillatory linear differential equations of the second order.'

The next regular meeting of the Society will be held on Saturday, April 27th. The Chicago section will meet at the University of Chicago, on Saturday, April 6th.

F. N. Cole,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of February 18th, 1901, 23 persons present, Professor J. L. VanOrnum read an address of general interest, summarizing the progress made in engineering during the nineteenth century.

A paper entitled 'Florida lichens,' by Professor P. H. Rolfs, was presented by title.

Professor F. E. Nipher showed two photographic negatives, developed by an ordinary pyro developer. One plate had been exposed in a printing frame for 1,000 seconds at a distance of a meter from a 300-candle lamp. It was then treated for ten minutes in a chromic acid bath having ten drops of an eight-per-cent. solution of chromic acid to three ounces of water. This treatment was in the dark-room. The plate was then developed in the dark-room.

The exposure of the other plate had been equivalent to a tenth of a second at the same distance from the lamp, and was exposed under the same plate. This plate developed normally in a pyro developer, having six drops of bromide and six drops of potassium ferro cyanide, both in ten-per-cent. solutions. The over-exposed plate showed more of detail, but the contrasts were less strong than in the plate with normal exposure. It looked like a slightly under-exposed plate.

When a plate with this exposure is treated with the chromic acid bath while in the light, and is then developed in the light, a positive picture results. The chromic acid bath may be replaced by ten drops of saturated potassium bichromate solution, and four drops of common C. P. nitric acid, to three ounces (90 cc.) of water. There is reason to believe that any camera exposure which was intended to be correct may be developed as a positive in the light by such methods. It is certain that it may be handled as a negative in the dark-room.

Professor Nipher stated that if either a negative or a positive had been started and had resulted in a failure, due to improper treatment, the picture with the fog on the plate might be chemically destroyed by chromic acid, and the picture might be redeveloped in either case either as a negative in the dark-room or as a positive in the light.

It was also stated that one plate had been developed as a superb negative at a distance of a meter from a 300-candle lamp. This case was

very remarkable, because, on account of an accident in the treatment, a failure or a poor positive had been expected. Several repetitions of this treatment had failed to yield this result again.

It is frequently observed that with a strong pyrocatechin developer the picture will start as a negative in the light, and will reach a fair degree of excellence, and then reverse. This is in the nature of an oscillation such as is known in electric discharges. The phenomenon is not observed in a weaker or in a more slowly acting bath. The anomalous case before referred to could hardly be accounted for in this way, because the picture developed very slowly in a normal hydrochinon bath, and grew steadily better until it was sharply defined on the back of the film. This case is still being examined.

A short biographic sketch of the late Charles Pierre Chouteau, a charter member of the Academy, who in its early years, as the western representative of the American Fur Company, contributed many important collections to its Museum, was presented by a committee appointed for that purpose.

Two persons were elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

A FIELD FOR MOSQUITO THEORISTS.

CLIMATIC CONDITIONS ON THE UPPER CONGO.

TO THE EDITOR OF SCIENCE:—The following extracts from letters of Father Grison, a Missionary at Stanley Falls, and Mg'r Roelens, Vicaire Apostolique of the Upper Congo, addressed to the Société Antiesclavagiste of Belgium, may be of interest. G. R. S.

WASHINGTON, D. C.,
February 12th.

At Stanley Falls the climate is very agreeable, but is formidable, as the victims of fever are too numerous. Europeans have very inaccurate ideas of tropical temperatures. I have passed eight years at the equator on the Pacific Coast, and have never seen the mercury above 29° C.

Here the maximum is 32° C. and the nights are deliciously cool. This is our climate all the year.

There is, however, a reverse to this picture. We have frequent tempests of indescribable violence; I have counted in one minute during a diluvial rain and continuous thunder, sixty-six flashes of lightning; and have seen in two hours within a radius of a few hundred meters, ten *coup de foudres*.

Mg'r Roelens at M. Pala, writes:

The work of the Mission allows me little leisure for anything else than an occasional attack of fever.

The fever, however, does not ask if you have the leisure, but imposes it at will, and unhappily, a little too frequently.

Dame fever reigns as mistress of the country.

In the rainy season, from November to May, her tyranny is most severely felt; no one escapes attack; the newly-arrived are most susceptible, but the old residents are not completely immune.

Those who have been resident more than a year are the chosen victims of the terrible hæmaturic fever (Malarial hæmaturic, or 'Swamp fever.') In five years' residence I have had the fever fourteen times! For the last two years, fortunately, it has left me in peace.

Brother Stanislas, who has resided here since 1893, is now sick with it for the twenty-fifth time.

It is an old saying here that the third attack is always mortal.

We, however, have passed the period when our lives are despaired of; this result is due to the treatment we have followed here.

Since 1892 the missionaries of the Upper Congo have applied this treatment to seventy-five cases of this fever, of which five only have been fatal.

Beside this there are no other grave climatic dangers for Europeans. The dysentery, which elsewhere is a serious menace, does not occur here.

I suspect that the English at the south of us find this malady more frequently in their boxes of conserves, and in *la dive bouteille*.

At this moment an epidemic of smallpox is invading the country. It is said here that this recurs every seven years, and attacks all who escaped the previous invasion.

We cannot depend upon the vaccine of Europe, because of the long voyage and the great heat.

I have given it many trials without result.

SHORTER ARTICLES.

ARE THE AUSTRALIAN MARSUPIALIA OF OPOSSUM DERIVATION.

AT the last meeting of the American Association for the Advancement of Science, in June, 1900, the writer presented some reasons in

favor of the view that the Australian Marsupials have been derived from opossum-like ancestors. Since then the opportunity has been afforded of examining the case in greater detail, and it may accordingly be of interest to notice certain of the results obtained.

As nearly every writer who has dealt with the group has observed, the Australian Marsupials exhibit extensive resemblances to Placentals in respect to certain features of their outer organization, notably the adaptive modifications of the teeth and feet. By means of a very reliable, though roundabout method, this fact may be made effective use of in determining the character of the Marsupial ancestors. Thus, by reference to the paleontological history of Placentals, it is possible to recognize the sequence of events in the development of their structural modifications, and from this to infer a similar sequence in the similar modifications of Marsupials. Then, by carefully excluding those forms which show obvious signs of degeneration, it is possible to select from the others those modifications which are primitive or original from those which are secondary or derived.

Such an analysis is easily effected because the Australian Marsupials, notwithstanding their great diversity of form, constitute an extremely simple and homogeneous group. They show no indications of having been derived from more than one ancestral type.

The stem-form is found to have possessed the following characters, or more primitive ones: Dental formula

$$i.\frac{5}{3}\ c.\frac{1}{1}\ p.\frac{3}{3}\ m.\frac{4}{4};$$

upper molar teeth triangular, each with three main cusps and an outer row of incipient styles; lower molar teeth each with an anterior triangle of three main cusps, an antero-external shelf, and a posterior heel with three terminal cusps. Foot with the great toe opposable, but with the other digits normal.

These characters are not found together in any one of the Australian forms, but, with one minor exception,* are exactly reproduced in the American opossums.

* The opossums have four lower incisor teeth.

In addition, it appears entirely probable that other structural modifications of the Marsupial organization are also departures from an opossum type. The anteriorly opening pouch of the kangaroos, wallabies, and phalangers, and the posteriorly opening pouch of the bandicoots appear to be modifications of a type like that met with in the opossums, where the opening of the pouch is directed vertically downwards. This condition has been preserved in the Australian dasyures. Again, it is probable that a scaly prehensile tail, like that of the opossums, has to be ascribed to the Marsupial stem-form, since various grades of an apparently disappearing prehensilism are to be met with in the phalangers.

There is also the significant fact that during the Oligocene period opossums were widely distributed throughout the northern hemisphere and that at a slightly later period opossum-like forms (Microbiotheriidæ) existed in South America. To this may now be added the probability that it was at about the middle of the Tertiary that the Marsupial radiation began. Of the latter there is the following evidence: The most advanced modifications of the teeth and feet in Marsupials (kangaroos) are decidedly primitive as compared with the most advanced modifications of the same structures in Placentals (Ungulates, especially the horses). Furthermore, although the Marsupials possess the representative characters of Placental orders, it is barely possible to separate them, in some cases, into families. Both of these facts indicate that the Marsupial radiation has been of much shorter duration than that of the Placentals, and therefore, if the Placental radiation began in the Cretaceous or early Eocene, the Marsupial radiation, as indicated above, could not have begun before the middle of the Tertiary.

If these indications are reliable, it would appear that the entire Marsupial fauna of Australia has been derived by a comparatively recent adaptive radiation from a single ancestral type, of which the American opossums are the existing representatives.

Naturally the greatest objection to such a view is the fact that there are no opossums in Australia at the present time. This difficulty is, however, quite a superficial one. If we

imagine the opossums to have originally gained access to the region, is it not preeminently fitting that, in establishing the foundation of an extremely comprehensive adaptive radiation, and under the favorable conditions of an absolute freedom from competition, they should have thrown aside their original didelphyid characters? And especially is this conceivable when we realize that the differences of structure separating the opossums from the most primitive of the Australian forms (dasyures) are extremely slight.

However unprogressive the opossums may at first sight appear to be, they are still plastic types. That they are at the present time attempting to radiate in South America is apparent from the numerous subgeneric divisions which it has been found necessary to establish,* and more especially from the fact that one form (Chironectes) has already become completely adapted to an aquatic life.†

The above conception approximates closely the general opinion, expressed by Lydekker,‡ in 1896, that the opossums and dasyures are the descendants of a common ancestral stock, but differs in assuming that these ancestors were opossums, and that they were formerly present in Australia. If we assign to the ancestors of the dasyures characters which would allow them to constitute the Marsupial prototype, they would no longer be Dasyures, but opossums. Ameghino has suggested the South American Microbiotheriidæ as ancestral to the dasyures, and Bernard (Éléments de paléontologie) regards the border as opossums.

B. ARTHUR BENSLEY.

COLUMBIA UNIVERSITY,
November 5, 1900.

WORK AT THE MARINE BIOLOGICAL LABORATORY OF WOOD'S HOLL, 1900.

THE course in physiology should be classified as a kind of research. The same is true in large measure of the course in embryology. In both of these courses, for instance, Dr. Loeb's experiments on artificial parthenogenesis were successfully repeated. Both of these courses are attracting students from medical colleges who feel the need of getting away from the strictly conventional physiology and embryology, into touch with the new lines opening up—in physiology, with the comparative study of biokinetics and in embryology with the new lines of thought introduced by experimental work and by the studies in cell-lineage. Both of these courses, as given here, are largely the outcome of the results of research of preceding years by members of the laboratory, who are themselves concerned in giving the instruction. They therefore represent the spirit of the laboratory along these two lines of investigation.

As regards investigation proper :—In PHYSIOLOGY, Dr. Loeb has continued his experiments on artificial parthenogenesis and has succeeded in inducing the development of unfertilized eggs of Annelids (see a recent number of SCIENCE). Other lines of work in physiology concern the chemical stimulation of nerves, the physiological effects of inorganic salts on the rhythmical activity of living tissues, similar studies on ciliary motion; and work on regeneration by several investigators.

In CYTOLOGY: work on *spermatogenesis* has been carried on by Dr. Montgomery, Mr. Downing and Miss Wallace; on *ovogenesis* by Mr. Arthur E. Hunt, Dr. H. E. Crampton and Dr. C. M. Clapp; on *fertilization* by Dr. Conklin, Miss Katharine Foot, Miss Strobell, Dr. F. R. Lillie, Mr. Martin Smallwood. Dr. E. B. Wilson has brought here his experimental work on fertilization and cleavage in the sea urchin eggs.

In EMBRYOLOGY work has been carried on in various lines: *Annelids* by Dr. A. C. Treadwell and Mr. R. S. Lillie, *parasitic copepods* by Mr. Edward Rynearson, *Cirripedia* by Mr. M. A. Bigelow, *fishes* by Dr. Cornelia M. Clapp, Miss Robinson, Dr. Neal and Miss A. C. Smith, *Monotremata* by Mr. B. A. Bensley, *Histogenesis of gastric glands of Amphibia* by Dr. R. R. Bensley, *Planaria* by Mr. W. C. Curtis, *Nucula* by G. A. Drew, *Parasitic Isopods* by J. R. Murlin.

The work in NEUROLOGY included the following: V. E. McCaskill on nervous system and metamerism of *Hirudo*, Mr. Fling

* Cf. Thomas, O., 'British Museum Catalogue of Marsupialia and Monotremata,' London, 1888, pp. 317-322.

† Cf. Gadow, H., 'On the systematic position of *Notoryctes typhlops*, P. Z. S.,' London, 1892, p. 370.

‡ Lydekker, R., 'A Geographic History Mammals,' Cambridge, 1896, p. 55.

on *Lumbricus*, Mrs. M. A. Bigelow on Olfactory nerves of Vertebrates, Dr. Neal on origin of motor nerves in Selachians, Dr. A. D. Morrill on histology of nervous system in planarians, Mr. Yerkes on physiology of pineal eye in lizards, Miss Marion Hubbard on the nervous system of *Dero*.

In Zoology: A monograph on *Arenicola cristata* is under way: The nephridia are being studied from the points of view of anatomy and embryology by Mr. R. S. Lillie, the spermatogenesis by Mr. E. R. Downing, Oögenesis by Mr. Arthur E. Hunt, Organs of circulation by Miss Emma Keith. The first part of this monograph, the embryology, by Dr. C. M. Child, is already published and other parts, including the ones mentioned, are well under way. The zoological studies not already mentioned include work on Coelenterata by Dr. Murbach, on *Hemiptera* by Mr. W. M. Chester, on *Pycnogonida* by Mr. L. J. Cole, on *Nemertea* by Miss C. B. Thompson, on *Pectinatella* by Miss A. W. Wilcox, on *Acmæa* by Miss M. A. Willcox, on *Amphipoda* by Dr. S. J. Holmes, on *Limulus* by Dr. Wm. Patten, on Lamellibranch gill by Dr. E. L. Rice, on *Annelids* by Dr. A. L. Treadwell.

In variation statistics and allied subjects, Miss M. M. Entemann on *Polistes*, Dr. E. C. Edwards on *Synapta*, Dr. H. E. Crampton on Lepidoptera, Miss A. C. Dimon on snails.

In Botany: Cytological work has been carried on by Dr. B. M. Davis, Miss C. M. Derick, Dr. Walter Swingle.

Physiological work has been carried on by Dr. R. H. True and Mr. Roberts. Dr. George T. Moore and Dr. Erwin Smith have also been working in this department.

NOTES ON INORGANIC CHEMISTRY.

From the current chemical journals the following notes are taken:

Professor Fittica still persists in his claims of being able to change phosphorus into arsenic and antimony and gives PN_2O as the true formula of arsenic, and $P_2N_2O_2$ as that of antimony. Christomanos, preparing arsenic, according to Fittica's directions, from commercial phosphorus, tests it without success for the presence of phosphorus and nitrogen, but Fittica replies that this should not occasion surprise, since methods used for testing in one class of compounds often fail when applied to those in which the nitrogen is more firmly united.

The cause of the much discussed poisonous qualities of arsenical wall papers has been shown by Biginelli to be due to the evolution of a gas, diethyl arsin, formed under the influence of the mold *Pencillium brevicaule*, which thrives on arsenic, and develops on arsenical papers.

Some time since reference was made in these columns to the work of H. J. Möller on the protective value of different colored glasses for chemical and drug bottles. His former method was photo-chemical, but he now finds the use of the spectroscope equally satisfactory, and much simpler, a pocket spectroscope answering every purpose. Glasses have a protective value in proportion as they absorb the blue and violet light from the line F to the line H. Dark red glass is the best but most expensive; the dark olive-green of cheap bottles is very satisfactory; dark brown-yellow bottles are effective, but lighter shades of brown, green or blue have little value.

The claims of Desgrez and Balthazard for sodium peroxid as a regenerator of the air in submarine navigation have caused Jaubert to claim priority, as having been at work on the problem for more than three years. According to the latter, however, sodium peroxid has many disadvantages, but he expects in the near future to publish results attained with other substances which are more effective, and cheaper than even compressed oxygen.

It has been noticed at various times during the past four years that the water of the river Rhone exhibits certain reactions characteristic of aldehydes. This is found by Causse to be due to the presence of ferrous oxy-thio-carbonate $FeCO_2S$, which is formed by the combination of carbon dioxid with ferrous sulfid. The latter results from the reduction of sulfates by organic matter. The compound is broken up by distillation, or on standing, with the formation of an ocherous deposit.

The reduction of sulfates in water to hydrogen sulfid has been supposed to be due to the action of Beijerink's *Spirillum desulfuricans*,

but this is questioned by Saltet, who finds that different micro-organisms are concerned in the process, and that the reduction proceeds in stages, as is the case with the reduction of nitrates to ammonia. Saltet has isolated a new micro-organism, *Bacillus desulfuricans*, which reduces sulfates to sulfites, but produces no hydrogen sulfid.

IT has been found by Matignon that metallic magnesium liberates from their oxids not only thorium, cerium and lanthanum, but also praseodymium, neodymium and samarium. Nitrogen, but not argon, is rapidly absorbed by all of these metals. When the last three are obtained from their oxids in the presence of hydrogen, they unite with it to form hydrids, which are dissociated when strongly heated. Moissan finds that the carbid of samarium, SmC_2, can be formed in the electric furnace in minute, transparent, yellow, hexagonal crystals. It is decomposed by water, the chief gaseous product being acetylene, though considerable hydrogen and members of the paraffin series are also formed. In this action it closely resembles the carbid of yttrium.

THE fact that Dewar has found hydrogen to be a constituent of the atmosphere gives much interest to the discovery of Gautier, that hydrogen is formed by the action of water on granitic rocks at temperatures considerably below a red heat. In one experiment a granite rock was heated with phosphoric acid and gave 1,400 cc. of gas per kilo, 916 cc. of which was hydrogen. With water, the quantity liberated is somewhat less. Ammonia is formed at the same time, and Gautier concludes that both these gases are derived from the action of water on nitrids, chiefly iron nitrid, though possibly some of the hydrogen may come from carbides. Matteucci found during a recent eruption of Vesuvius, pieces of rock, coated with ammonium chlorid and iron nitrid, which would seem to show a close relation between these substances.

IN a short paper in the *Berichte*, Giesel confirms the observation of Walkhoff as to the effect of radio-active substances on the skin, similar to that of the Röntgen rays. He placed a celloloid capsule containing a quarter of a gram of radium, under his arm, and in two hours a slight reddening was apparent. In the course of two or three weeks considerable inflammation was present, with darkening, and finally loss of the skin. A similar action was found to take place on the leaves of living plants, and salts, glass and paper were also affected.

J. L. H.

ZOOLOGICAL NOTES.

DR. ANTONIO PORTA, of the Institute of Zoology and Comparative Anatomy at the University of Parma, has lately published in the Proceedings of the Royal Institute of Science and letters of Lombardy his researches on *Aphrophora spumaria* and, in a footnote, he says, "I had already finished the present paper when I received a pamphlet by Professor Morse in which he discusses the formation of the froth in the *Aphrophora spumaria*. It was with genuine satisfaction that I found there a confirmation of observations that I had made. Moreover, I repeated one of his excellent experiments, which leaves no doubt whatever of the fact that the insect emits a liquid only. Placing a larva on a piece of absorbent paper in order to dry it and then upon a glass, if we allow a drop of our saliva to fall upon it, it begins to fill this liquid with air-bubbles."

It is a curious fact that Mr. Morse gave an account of the manner in which the so-called spit-insect makes the froth on grass in his 'First Book of Zoology' twenty-five years ago. German editions appeared in Stuttgart and Berlin, an English edition was also published, and finally the book was translated into Japanese, and yet every general work on entomology has repeated the erroneous ideas regarding the habits of this creature. Even the last volume of the Cambridge Natural History series continues the error. In May of last year Mr. Morse published in the *Popular Science Monthly* an extended account with illustrations explaining more in detail the habits of the larva, and its method of forming the froth and it is to this paper that the Italian naturalist refers.

NOVA PERSEI.

PROFESSOR EDWIN B. FROST writes to the *Astronomical Journal* from Dartmouth College,

under the date of February 25th, in regard to the new star as follows: "This brilliant object attracted my attention at eleven o'clock on the evening of February 22d, before the receipt of the announcement of its discovery by Dr. Anderson. It was at that time to my eye brighter than a standard first magnitude star, and showed a distinct yellowish color, recalling to my mind the shade of *Nova Aurigæ*. It was cloudy here on the 23d, and the spectrum was first examined, between clouds, on the 24th, from 6^h 30^m to 10^h 30^m E.S.T. The observations were made with a McClean direct-vision star spectroscope attached to the nine-inch refractor of the Dartmouth Observatory. The general appearance of the visual spectrum was quite similar to that of *Nova Aurigæ*, with the bright components of the doubled lines on the less refrangible side (toward red). The dark components appeared relatively more intense, however, than in case of *Nova Aurigæ*, probably in great part a result of the superior brightness of the present star. The dark band on the more refrangible side of *C* was especially broad, much more so than in Campbell's drawing of the visual spectrum of *Nova Aurigæ*. Although the spectroscope employed does not permit micrometer settings to be made, the identification would seem to be sufficiently exact of the hydrogen lines $H\alpha$ and $H\beta$, the sodium lines at *D*, the magnesium group *b* (in whole or part), and probably the strong line at λ 5016—all these being represented by dark and bright components. Numerous other lines were seen which can not yet be identified. Singularly enough, the helium line D_3 was very faint or absent (the identification of the sodium lines being assumed). This was also the case with *Nova Aurigæ*."

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*THE ASSOCIATION OF AMERICAN UNIVERSITIES.**

I HAVE the honor to report upon the second annual meeting of the Association of American Universities, which I attended by your designation as the representative of Columbia University.

The meeting was held at Chicago, February 26–28, 1901. The opening session was held at Chicago University, and the subsequent sessions at the Fine Arts Building on Michigan Avenue. Each of the fourteen institutions represented in the Association was represented by one or more delegates. Each session was well attended by the delegates, and the discussions were practical and earnest. Newspaper reporters and the general public were excluded from the sessions, which, therefore, took on the very helpful form of a conference or a committee meeting. At the close of each session the Secretary gave out to the press such information as he thought proper.

The three topics chiefly discussed were: (1) inter-university migration of graduate students; (2) fellowship; and, (3) the examination for the degree of doctor of philosophy.

Upon each of these topics a short report was presented by a delegate designated in advance for the purpose. Each discussion brought out the details of the practice of the several institutions in regard to each of the matters considered, and while the Association refrained from passing resolutions, certain conclusions were arrived at by what was substantially unanimous consent.

It was held in regard to the first topic that it is wise to promote by all possible means the inter-university migration of graduate students, to the end that they may come under the guidance of teachers of varying points of view, and so may receive the broadest possible introduction to their chosen field of study. The only limitation suggested upon this migration was that circumstances being what they are, it might be unprofitable to the student for it to continue after he had made some progress upon his dissertation.

As regards the question of fellowships, it was held by a majority of those who spoke, that the provision for university fellows in this country is already too large, and that there is danger of stimulating unduly a number of men to go forward to investigation and research who have not the highest and best qualifications for such work. The opinion was expressed that it would be advisable to make some of the fellowships distinctly research fellowships, to be awarded only to students who had already

* Report of Professor Nicholas Murray Butler, delegate from Columbia University to President Low.

taken the degree of doctor of philosophy, and who had, therefore, received their academic equipment for their life work.

In discussing the best type of examination for the doctor's degree, it was held very emphatically that the practice which is growing up in our universities, especially in some of the departments dealing with natural science subjects, of permitting the candidate to pass his examination course by course, as is usual in undergraduate instruction, is a pernicious one, and one which stands in the way of the attainment of the best and broadest scholarship. It was held that the examination for the doctor's degree should, in all cases, be upon subjects and not upon courses of instruction; the underlying principle being that the courses of instruction which a graduate student attends are but a small part of the work which he is supposed to do in order to prepare himself for his examination.

It was developed that there was some difference of practice between the universities as to the formal examination for the degree of doctor of philosophy. On the whole, I think it may be said that it was the opinion of most of those who expressed themselves, that great stress should be laid upon the oral examination at the time when the candidate finally presents himself for his degree, and that if any subordinate examinations are held previous to this time, either upon courses or upon subjects, they should be given very little weight in estimating the capacity of the candidate.

It was voted unanimously to approve the suggestion of the committee appointed by the Council of the American Association for the Advancement of Science, that there be set aside a week to be known as Convocation Week, in order that the various learned societies of the country may arrange to hold their meetings at that time.

It was also voted to print in pamphlet form an abstract of the proceedings of the first and second annual meetings of the Association, and to assess the cost thereof upon the fourteen institutions equally.

The place and date of the meeting of 1902 were referred to the incoming executive committee with power.

The officers chosen for the year were: *President*, Columbia University; *Vice-President*, University of Michigan; *Secretary*, University of Chicago; additional *Members of the Executive Committee*, Harvard University, University of California.

THE NAVAL OBSERVATORY.

SENATOR CHANDLER'S amendment to the Naval Appropriation Bill, providing a Board of Visitors to the Naval Observatory and requiring the Superintendent to be a line officer of the Navy not below the rank of Captain, was, after stout and repeated resistance by the House conferees, at last accepted, with, however, an amendment, consisting of the words 'until further legislation by Congress,' the concluding clause reading: "The Superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the Navy of a rank not below that of Captain." This, of course, indicates that in the opinion of the House conferees further legislation should follow. The bill was finally passed by both Houses without debate on these provisions.

It appears from the following extract from the Washington *Evening Star* of the 8th inst., that the affairs of the Observatory are likely to be kept before the public:

Charges have been preferred to the Navy Department by Capt. Charles H. Davis, U. S. N., superintendent of the United States naval observatory, against Professor Stimson J. Brown, director of the Nautical Almanac, head of the mathematical branch of the observatory, who is an officer of the navy with the rank of captain. Both officers are well known in naval and scientific circles. The Secretary of the Navy has had copies of the charges laid before Professor Brown, preliminary to the usual procedure of a court of inquiry, which will determine whether the charges are of a character to warrant a court-martial.

It was at first understood that Professor Brown had been placed under arrest by Captain Davis, but it is said in some official quarters that there has been no arrest, and in others it is stated that, at most, the arrest is technical, following the preferring of charges, and in no way involving any restraint.

The papers were first transmitted to Admiral Bradford, chief of the bureau of equipment, who has supervision of the Observatory, and by him they were laid before Secretary Long. The papers are not made public in such cases and, owing to the personal nature

of the controversy, the officials have surrounded the matter with the greatest secrecy.

It can be stated, however, that the charges come under four main heads, viz., that the accused resorted to intriguing methods to bring about the administration of affairs which he desired; that he made statements as coming from Captain Davis which that officer controverts; that he threatened the superintendent with attacks upon the floor of Congress, and neglect of duty.

For the present the action of the Navy Department awaits the course that Professor Brown may adopt on the copy of the charges which has been laid before him.

SCIENTIFIC NOTES AND NEWS.

We record with much regret the death of Dr. George Mercer Dawson, director of the Geological Survey of Canada, which occurred on March 2d, after an illness of only two days.

Dr. Samuel W. Stratton has been appointed by President McKinley director of the newly established National Bureau of Standards. Dr. Stratton is professor of physics in the University of Chicago, but has, for the past year, had leave of absence to take charge of the Office of Standard Weights and Measures.

The President has also appointed a Board of Visitors to the U. S. Naval Observatory, in accordance with the provisions of recent legislation, as follows: St. Clair McKelway, of Brooklyn, N. Y.; Asaph Hall, Jr., of Ann Arbor, Mich.; William R. Harper, of Chicago; Edward C. Pickering, of Cambridge, Mass.; Charles A. Young, of Princeton, N. J.; Ormond Stone, of Charlottesville, Va.

Dr. Robert Bell, one of the assistant directors of the Geological Survey of Canada, has been appointed director in succession to the late Dr. George M. Dawson.

Mr. J. E. Spurr, of the U. S. Geological Survey, has accepted an invitation of the Turkish Government to make an investigation of the mineral resources of the country.

Dr. W. B. Scott, professor of geology in Princeton University, expects to leave in May for South America in the interests of the work carried on in Patagonia by several Princeton expeditions.

Mr. W. H. Fisk, of Durham, N. C., has been appointed assistant State entomologist of Georgia.

Signor Marconi was one of the passengers on the *Majestic* which left Liverpool for New York on March 6th.

At the annual meeting of the Hunterian Society, London, on February 13th, Dr. J. Dundas Grant was elected president of the Society. The annual address was given by Mr. John Poland, who gave a retrospect of surgery during the last century.

On account of ill-health Dr. Frank Russell has been compelled to omit some of his courses in anthropology at Harvard University, and to relinquish others to another instructor. Having been ordered to a more healthful climate he will occupy the year of exile in carrying on archeological investigations in the Southwest.

Professor George S. Wilkins, C.E., professor of engineering at the University of Alabama, has been made Chevalier of the Legion of Honor by the French Government for services on the International Jury of Awards of the Paris exposition. Professor Wilkins was expert of the department of civil engineering and transportation for the commissioner general of the United States at this exposition. He was also the official United States delegate to the following International congresses: Tramways, Applied Mechanics, Technical and Industrial Education and Acetylene Gas.

In memory of the late Dr. Walter Myers, whose life was sacrificed in the study of yellow fever, a chair of tropical medicine has been endowed in the Liverpool School of Tropical Medicine, to be called the Walter Myers' chair. A gravestone will be erected where Dr. Myers is buried in Brazil, and a memorial plate will be placed in the Birmingham Hospital.

Dr. John Minot Rice died at his home in Northboro', Mass., on March 2d, at the age of 68 years. He was a graduate of the Lawrence Scientific School, Harvard University, and was appointed professor of mathematics at the Naval Academy at Annapolis in 1870.

There will be a civil service examination for the position of topographic draughtsman in the office of the surveyor general at San Francisco.

The salary is $1,200, and the examination is on geographic projections, mathematics, and topographic drawing and lettering.

MR. ANDREW CARNEGIE has offered the following sums for library buildings, on condition that the cities mentioned shall provide the cities and ten per cent. of the cost of the buildings annually for maintenance: Richmond, Va., $100,000; Montgomery, Ala., $50,000; St. Joseph, Mo., $25,000; Johnstown, N. Y., $20,000; Ashtabula, Ohio, $15,000.

MR. HENRY H. ROGERS, of New York, has presented to the Millicent Library of Fairhaven, Mass., the water-works of that town, yielding an annual income of about $8,000. The Millicent Library was given to the town of Fairhaven in January, 1893, by the children of Mr. Rogers, in memory of their sister Millicent G. Rogers.

BY the will of Dr. Abbott Hodgman, his library is given to the New York Academy of Medicine.

THE Milwaukee Public Museum has just acquired the Rud. J. Nunnemacher collection, containing a large series of Buddhist, Confucian, Taonist and other divinities from China, Japan, India, Burma, Siam and Northern Thibet, in terra cotta, wood, bronze and brass.

We learn from the *Astronomical Journal* that Mr. A. F. Lindemann, of Sidmouth, England, has placed means at the disposition of the *Astronomische Gesellschaft* to be administered by a committee consisting of H. Seeliger, E. Weiss, G. Müller and H. Kreutz for the purpose of accelerating the work of calculation of comet-material from ancient times to the middle of the nineteenth century. The conditions are briefly as follows: An average amount of 100 Marks (about $24) will be paid for definitive cal culation of the orbit of one of these comets, the award being lower for those requiring a relatively small amount of time and higher for those presenting especial difficulty. The award will be made to the first calculation which sufficed the requirements of a definitive computation, but may be divided in case of simultaneous determinations. The committee will decide in each case whether the requirements are met and the amount of payment. A list of these comets, some seventy in number, may be obtained from Dr. Kreutz, who should be communicated with, in order that duplicate calculations may be avoided.

THE officers of Section D — Mechanical Science and Engineering—American Association for the Advancement of Science, Professor Henry S. Jacoby and Mr. William Harry Jacks, have issued a circular in regard to the Denver meeting. It reads in part.

The subjects which are appropriate for the Section relate more especially to the application of science and of scientific methods to the various engineering problems.

It has been suggested that short papers be presented, giving information regarding the following questions: Have you any experimental data which either confirm or throw doubt upon formulas or constants hitherto generally received? Have you any data upon subjects hitherto considered doubtful, as for example, the strength of unstayed surfaces? What subjects should engineering laboratories undertake to investigate with a view to obtaining data which will be of general importance, and how would you propose to make such tests (including a description of the apparatus)?

It is hoped that many brief résumés of investigations or experiments relating to different subjects of interest to the Section may be offered for this meeting, and that the support of the Section will be shown by the offer of a larger number of appropriate papers than usual, especially by the Western members who have long urged a meeting in the far West.

THE fifth annual meeting of the New York State Audubon Society was held in the American Museum of Natural History on the afternoon of March 8th. Addresses were announced by Dr. Frank M. Chapman of the Museum, Dr. T. S. Palmer, assistant-chief of the U. S. Biological Survey and Mr. Charles R. Skinner, State Superintendent of Public Instruction.

IN order to aid in the extension and further equipment of the Scientific Department, of Manhattan College, New York City, Dr. J. M. Ferrer and a committee of the alumni society have organized a course of five evening lectures to be given in Carnegie Lyceum during the month of April. They have secured the cooperation of men eminent in their respective departments, as will be seen from the following syllabus:

April 10—'Meteors and Meteorites,' by Professor M. F. O'Reilly, D.Sc., London.

April 16—'Development of Artillery in the Nineteenth Century,' by Captain Edward L. Zalinski, U. S. A.

April 22—'Submarine Boats,' by Mr. John P. Holland.

April 25—'The Steam Engine and its Rivals,' by Professor R. H. Thurston, of Cornell.

April 30—'Electric Wave Transmission,' by Professor Michael I. Pupin, of Columbia.

The lectures will be illustrated with stereopticon views. Professor Pupin will further illustrate his lecture by experiments with apparatus used by him in the researches which have led to his recently announced discoveries in connection with the transmission of speech over long-distance telephones and submarine cables.

At the International Congress on Tuberculosis to be held in London in July, addresses will be delivered by Professor Robert Koch, Professor Brouardel, dean of the medical faculty of the University of Paris, and by Professor McFadyean, principal of the Royal Veterinary College, London.

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Mr. Hiram Sibley, Jr., has given Cornell University $85,000, for an addition to the Sibley College of Engineering. It will connect the two present buildings, and give them a frontage on the campus nearly 400 feet in length.

Mr. John D. Rockefeller has given $110,000 to Vassar College for the erection of a residence hall similar to the residence hall now being built on the college grounds.

Mrs. L. M. Palmer, widow of Dr. A. B. Palmer, for many years professor in the medical department in the University of Michigan, has by the terms of her will left $85,000 to the University, mostly, it is understood, for the benefit of the hospital.

The District Court at Denver has sustained the will of the late George W. Clayton, who bequeathed most of his estate, valued at more than $2,000,000, to the city of Denver for a college for orphan boys, similar to Girard College, Philadelphia.

The following statement has been issued in regard to the consolidation of the Chicago Institute with the University of Chicago: "The Chicago Institute is to become a professional school of the University of Chicago, and will include a school of pedagogy and an elementary school and kindergarten. Associated with it will be a secondary or high school, for the present under the leadership of Dr. John Dewey of the university, ultimately, however, to become a part of the Chicago Institute. Colonel Parker is to be the head of the institute, and his successors are to be appointed by the university trustees upon the nomination of the Chicago Institute trustees. With the institute the university receives $1,000,000. Part of this is to be used in furnishing a home and equipment for the institute, and the rest is to be devoted, chiefly as an endowment fund, to the maintenance of the institute. The university expects to expend from its own funds between $10,000 and $20,000 a year for the support of the work."

It is expected that the Hall of Fame of New York University will be formally inaugurated on May 30th.

Owing to the increase in the number of Assembly districts in the State of New York, Cornell University will hereafter provide 150 free scholarships each year in the place of 128. To educate the 600 students holding these scholarships costs, as President Shurman has pointed out, $180,000, whereas the University received in return a land grant from which the annual income is but $35,000.

Dr. W. T. Jordan, of the University of Tennessee, has been offered the presidency of the University of Alabama.

At Columbia University the following promotions have been made: M. I. Pupin, professor of electro-mechanics; Marston Taylor Bogert, adjunct professor of organic chemistry; Edmund H. Miller, adjunct professor of analytical chemistry and assaying; S. L. R. Morgan, adjunct professor of physical chemistry; Livingston Farrand, adjunct professor of psychology, and Edward Thorndike, adjunct professor of genetic psychology.